THE WORLD IS ITS FIELD.

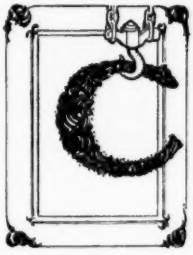
THE ENGINEERING MAGAZINE

VOL. XXI. MAY, 1901. NO 2.

BRITAIN AND HER COMPETITORS IN IRON AND STEEL MAKING.

By E. Phillips.

Since this article was written, the most gigantic trust ever known has been formed in the American steel trade. The physical conditions of production reviewed by Mr. Phillips, however, are unchanged, except that specialisation and intensification have yet larger scope. Whether this Titanic system can be co-ordinated and unified—whether the enormous requisite dividends can be earned—remains to be seen. But one thing is certain. Industrial expansion is dependent on cheap steel. The nation which fails to secure it—fails by tolerance either of false political economy or of commercial blindness—will lose its ascendancy.—THE EDITORS.



CONSIDERATION of the question of the present conditions and future tendencies of the iron and steel industry is of far-reaching and vital importance to the future of Britain and of those engaged in her engineering works; so much so that if Britain is to continue to retain a goodly share of the world's orders, and to maintain her hitherto national position as the leading manufacturing "workshop" of the world, she must at once wake up and ascertain the causes which have brought about the recent competition in iron and steel products, not only in what in the past were Britain's exclusive markets, but also in her home orders. She must ascertain if anything can be done to meet the new conditions which threaten to overwhelm her. Less than twenty years ago Britain was a larger producer or iron and steel than any other country in the world, but during the last decade such has been the expansion and development of Germany and America (but more especially in the latter) that from the position

Copyright, 1901, by John R. Dunlap.

of industrial supremacy, England has dropped to the third place in the production of iron and steel, as the following statistics prove:

PIG-IRON PRODUCTION.

In 1889 Britain made	8,322,824 tons.	America made	7,603,642
In 1899 Britain made	9,000,000 tons.	America made	13,620,703
Increase	677,176 tons.		6,018,061

STEEL PRODUCTION.

In 1890 Britain made	3,679,043	Germany	2,239,099	America	4,277,071
In 1899 Britain made	4,855,325	Germany	6,250,000	America	10,639,857
Increase	1,176,272		4,010,911		6,362,786

The foregoing figures show very conclusively that the increased growth of production in Germany during the last decade was nearly four times as much as that in England, whilst that of America was nearly six times greater.

In 1890 Britain exported 4,001,430 tons, but in 1899 only 3,717,180 tons; whereas the value of American exports increased from $25,542,000 in 1890 to $105,690,000 in 1899; England thus showed a decrease of nearly one-fourteenth, whilst America quadrupled her exports. The American exports of iron and steel to England in 1890 amounted to 222,776 tons. In 1899 this was increased to 333,113 tons, sufficient (with the lower rates at which they were able to deliver it) to cause a "slump" in prices, and to turn what was before a profitable industry into an unprofitable one, at the recent high prices of coal, coke, ore, and wages in England.

As further illustrating the effect of this importation on local steel-making works, it may be mentioned that 25,750 tons of American bars were delivered at Alexandra Docks, Newport, in 1900, and 24,521 tons at Swansea and Cardiff, in all 50,271 tons for South Wales works; and when it is considered that each ton of steel represents two tons of ore, the significance of this is evident. As a result, there was a great falling off in British ore importations. The Board of Trade returns during the twelve months of 1899 shows that the amount of ore received at Newport was 611,915 tons; during the corresponding twelve months of 1900 it was only 424,700 tons, showing a decrease of 187,215 tons, chiefly due to American competition. And what applies to Newport, applies more or less equally to the northern ports of England. The consequence was that local works have only been partly employed. The Board of Trade returns of the quantity and value of iron ore imported during the years 1899 and 1900 to eleven of the principal ports of the kingdom, viz., to Barrow, Cardiff, Maryport,

Middlesborough, Newcastle, Newport, South Shields, Stockton, Swansea, Ardrossan, and Glasgow, were as follows:

In 1899, ore imports.....7,054,578 tons, of the value.....£5,374,918
In 1900, ore imports.....6,297,873 tons, of the value..... 6,639,003

showing a decrease in quantity of 756,705 tons, but an increase in value of £264,085. There are twenty-six other smaller ports which imported about 750,000 tons, the Board of Trade returns for which are not yet published.

It is interesting to note that in 1876 (a quarter of a century ago) the import of ore into the kingdom was only 672,236 tons; now it is about 7,000,000 tons. The out-put of iron ore raised in the kingdom in 1874 was 14,844,931 tons; in 1899 (twenty-five years later) it was only 14,461,320 tons. There have been fluctuations in the intervening years, sometimes more and sometimes less, but practically the amount raised is the same as it was twenty-five years ago; so that any increase in British make must come from imported ore. Two-thirds is now raised in the kingdom and one-third imported, but as far as South Wales is concerned it is practically all imported ore that is used.

Without being over pessimistic as to the future, it is quite evident to those who have the welfare of England at heart and see the trend of the new conditions they have to face, that very drastic remedial measures will need to be adopted; otherwise retrogression of the next decade will be much greater than that of the past. It will not do to say as some do even now, "Oh, this competition of the Americans is a mere 'flash in the pan;' they are only 'dumping' down their surplus so as to keep up prices at home, and they do it at a loss. Wait a little till ore, coal, and wages return to a more normal state, and this innovation will soon come to an end. They will get tired of sending their stuff here at a loss." But will they, or do they send it at a loss?

Up to the present only a few of the British manufacturers, and we fear none of the workmen, in the iron industries have at all realised the forces that are at work, the magnitude and enormous natural advantages and resources which the Americans possess, with their cheap ore and coal combined with their skill and enterprise, their labour-saving appliances, their low railway rates and water freightage of their ores from mines to furnaces, and the best equipped works in the world. All this places them at a great advantage, whilst England has hitherto been working according to antiquated "ding-dong" methods. The consequence is that unless she at once wakes up and adapts herself to the new requirements, her past prestige will pass away. Those manufacturers who have visited the States are quite alive to the seriousness

of the situation, and they appreciate the necessity for themselves and their engineers to invent new methods, and to adopt those in operation in America, so as to reduce the cost of manufacture and bring themselves into line with the most modern adaptations, thus fitting themselves to compete in the coming race with American competition. If this is done, Britain may yet supply a fair proportion of the world's requirements of steel products, but if she fails to rise to the occasion her past industrial pre-eminence will pass away.

The abnormal state of Europe in the past two years, with the boom in prices and the consequent advance in the raw material—of ore, coal, and wages—to nearly double what it was in the more normal state, no doubt gave America the opportunity to step in; for it must be borne in mind that whilst raw materials went up in Europe, this was not so in America, their ore and coal costing no more than formerly. The inflated costs of production caused the price of tin-plate bars (and all other products) to advance from £4.0.0 to £7.10.0, whilst American bars were delivered in England at £5.5.0, notwithstanding that they had to pay 7s. 6d. per ton for railway rate from Pittsburg to Baltimore and Philadelphia, the ports of shipment, and a further oversea freight of 17s. 6d. to 20s. to Britain, something like 27s. 6d. from Pittsburg furnaces to English ports. Welsh manufactureres have tried to stem this importation by reducing the price of bars to £5.0.0, which is below present cost. Americans have met this by reducing to £4.15.0, and are prepared to go lower if found necessary.

The question now comes to this: How is it possible for the American manufacturer to do this, and pay 25s. to 27s. 6d. railway rate and freight from works to Britain. Are they subsidised by Government bounties to do so? No, they are not. Do they "dump" down their products here at a loss? The reply is: No! Will the Americans be able to compete in England and the markets of the world when the prices of ore, coal, and wages come down to their more normal price? Americans say: Yes; they can. These are heart-searching questions and problems to manufacturers at the present time of industrial decline. I therefore propose giving detailed data of the comparative costs and methods in America and in Britain, commencing with the ore in the mines and proceeding to the finished steel product in the mills. I venture to think this will be an "eye-opener" to those interested in iron and steel manufacture.

American and British Costs Contrasted.—To make cheap steel, the following are esesntials. Cheap railway rates, low sea or lake freights to bring ore to furnaces, cheap coal and coke, a large output pro-

duction, mechanical labour-saving appliances, and a low wage-rate cost per ton on the output, whilst paying the men good wages.

American railways are cheaply made, by reason of the land being cheap. Concessions of an extensive width of land were granted to promoters on either side of the railway, which is a valuable asset as the districts develop; the effect is that railway rates are only about one-sixth of what they are in Britain. Further, it should be borne in mind that the great steel-making firms and trusts own or are interested in the mines, the railways, and the fleet of lake steamers. The distance from Pittsburg to Conneaut Harbour, on Lake Erie, is about 155 miles. This line, known as the Pittsburg, Bessemer, & Lake Erie, is virtually Carnegie's own, so that he can fix his own rates for ore to works, and finished steel back to Lake Erie. Then again, Carnegie and his associates have their own mines, and operate very closely with J. D. Rockefeller, who controls large properties on the Lake Superior Ranges. The steel-making interests control also their own railway from the mines, known as the Duluth, Mesaba & Northern Railway Co., running from the so-called Mesaba Range to Duluth, where the ore is handled by the Bessemer S. S. Co.'s fleet, also the J. D. Rockefeller property, the most modern and up-to-date fleet of vessels on the Great Lakes. The average season rate from the head of the lakes to lower lake ports is about 2s. 6d. per ton, but Carnegie does not pay this. He and J. D. Rockefeller have long contracts at lower rates. The Federal Steel Co. are also in much the same position as the Carnegie Co.; they own and control their own mines and railway from mines to shipping port, known as the Duluth & Iron Range R. R., to shipping ports at Two Harbours; they also control a large fleet of about fifty steamers on the Great Lakes, under the name of Pickands, Mather & Co.; they have also their own coal properties, and produce large quantities, if not all, of their own coke. What the cost of ore, coke, etc., would be to an independent furnace-man and steel manufacturer (of which there are now very few, by reason of their absorption into the trusts), these companies—the Federal, Carnegie, National, Republic, and others—can reduce very considerably. Then again, the bye-product system of making coke is being introduced all over the States, resulting in a very great saving all round; that is, the sale of the bye-products and gas, either for light and heat, will give the furnace-man his coke free; furthermore, the increased capacity of the modern furnace, with large stoves and the increased blast, results in a great saving of coke in the burden of the furnaces, working as low as 1,650 pounds of coke to the (2,000 pounds) ton of pig iron.

The outcome of all this is that the Americans have no royalties to pay—no mine owners' profit, only the cost of digging out the ore—no railway dividends to pay, which is generally about one-half the earnings of the railway—no 10 to 50 per cent. dividends to ship owners, their payments being only for coal, wages, and repairs, and a moderate rate of interest on the capital outlay in the railway, mines, and steamers.

Let us now consider in detail what these extra burdens are that the British manufacturer has to pay.

Take royalties; this charge runs from 6d. to 1s. per ton on coal and ore (home raised), which, on the quantity used to make a ton of steel, amounts to 5s. per ton. Next, take the cost of Bilbao ore; in normal times he has to pay at least one-third more at Bilbao than the American ore costs delivered into boats at Lake Superior (to say nothing of having to pay last year an advance to Bilbao mine owners of 7s. per ton, and a further advance of 4s. more than formerly in freight), bringing the price, with freight, up to 21s. at ports of delivery. With tolls to works, this would be 22s. to 23s.—considerably more than double the cost of ore delivered at Pittsburg furnaces.

American Mode of Handling and Shipping Ore. The ore from Lake Superior ranges in many cases is obtained very cheaply from the mountain sides, and when dug out is loaded into twenty-five ton wagons by steam shovels, which pick up five tons at a time. The twenty-five ton wagons are loaded in two and a half minutes. The cost of the ore in many instances is not more than 1s. per ton into trucks; in other cases it has to be mined by level and by pits, which is more expensive. The cost at port of shipment in such cases may range from 2s. 6d. to 5s. per ton. Lake Superior ore contains from 60 per cent. to 65 per cent. of iron, as compared with Bilbao ore of only 50 to 55 per cent. American ore is thus 10 per cent. richer in iron than that of Bilbao or than English native ore. The ore is brought to the shipping sidings at Lake Superior. It is there sampled from the trucks and assayed before shipment. Ore containing phosphorus up to 0.045 to 0.050 per cent. is accepted by American steel manufacturers, and steel rails and bars are delivered to buyers with a maximum of phosphorus not exceeding 0.10 per cent. Their rails, bars, etc., are accepted both in America and in England on the basis of a maximum of 0.10 per cent. phosphorus and 0.10 per cent. carbon, whilst British manufacturers have to stipulate in their ore contracts that they will not receive ore containing more than 0.025 per cent. to 0.030 per cent. of phosphorus, because buyers of steel will not take delivery except it be

below 0.07 per cent. of phosphorus. The basis of 0.06 per cent., with the maximum of 0.07 per cent. is the British standard; anything above is rejected. This is a very serious handicap, for there are millions of tons of Spanish ore between 0.025 per cent. and 0.05 per cent. of phosphorus, obtainable at a much less price than now paid for ore, which could be used to make steel with a maximum of 0.10 per cent. of phosphorus. How to remedy this we shall have more to say later.

Lake Superior's Shipping Facilities. To give a clear idea of this, we may say that there are several stage tips of 2,000 feet each in length, alongside of which three steamers, each carrying 5,000 to 6,000 tons can lie. These steamers are 500 to 600 feet long, with five or six self-trimming hatchways, and they can lie end to end at each stage; so there may be nine steamers loading at one at the same time at the three stages, with easy delivery to each hatchway of all the, say, nine steamers. A chute passes under the stage to the trucks on top; these trucks, of twenty-five-tons capacity each, have bottom trap-doors, by which to discharge the contents. Connected with every chute on the whole line of stages are large bins, holding from 150 to 200 tons each of ore, with trucks above over each with more ore. When the steamers come alongside, the chutes are pushed forward to the six hatches in each, the wings of the bins are opened, and about 1,000 tons is simultaneously shipped into each steamer; the trap doors of trucks are then opened to deliver contents, and additional trucks are brought over, so that in a few hours a series of boats are ready to sail the 800 to 1,000 miles to destination. Then, again, mechanical appliances are employed for quick discharge into fifty-ton trucks. Very powerful engines take thirty of these fifty-ton trucks—or a train load of 1,500 tons of ore—to Pittsburg. This rapid loading and discharge of the steamer will explain how it is the freight can be done for 2s. to 2s. 6d. per ton. Contrast this with what is done to bring ore from Bilbao to English ports, a stipulation in the charter party being that shippers shall not be required to load nor receivers at destination to discharge more than 300 to 400 tons per day. Add to this, that boats at Bilbao may have to wait days, and even weeks, for their turn at tips. All this delay has of course to be considered in the freight.

The foregoing shows how labour costs are minimised by the use of steam shovels at the mines, by trap-door self-discharging trucks, by self-delivery from the bins under stages to self-trimming steamers, by the discharging the steamers into trucks at terminal port with but little manual labour other than the superintendence and manipulation

of the various mechanical arrangements, Compare this with the British and Spanish methods of loading and unloading trucks and of steamers by manual labour and hand shovelling of the ore at mines, steamers, and works. It will be apparent how mechanical appliances reduce labour costs in the manipulation of ore. Here I may say that American mines raise 17,000,000 tons annually.

Freights on the American Lakes, and from Bilbao to British Ports. The average British cargo steamer carries 2,000 tons. The American lake steamers carry 6,000 tons. The English steamer therefore has to make three trips from Bilbao to Britain to deliver as much as the lake steamer carries in one trip to port of delivery. The distance in both cases is practically the same, that from Bilbao being 1,100 miles, and that on the lakes 800 to 1,000 miles. This means that the number of men employed, the amount of coal used, the cost of repairs, insurance, etc., is three times as large to convey the 6,000 tons in English steamers as it is on the lakes.

The average freight from Bilbao over a period would be about 4s. 6d. per ton, a minimum being 3s. 9d. and a maximum 7s. 6d. The average time for a round voyage may be taken as two weeks, viz: Outward voyage three days, waiting turn for tip at Bilbao and time discharging four days, homeward voyage three days, waiting turn for berth and time discharging four days, total fourteen days. First 2,000-ton cargo, two weeks; second 2,000-ton cargo, two weeks; third 2,000-ton cargo, two weeks—making six weeks for the 6,000 tons, which the Lake steamer delivers in *one* week—the Lake steamer's time being, outward passage two days, loading one day, returning two days, and discharging two days—in all, seven days.

The *extra freight cost* to Britain is then at least 2s. 6d. per ton over lake freights. It takes two tons of ore to make one ton of steel; this means a *permanent* extra cost of 5s. per ton of steel more than is required in American practice for freight transit alone. Add to this the extra for royalties on coal, etc., amounting, as before said, to 5s. per ton of steel, and it appears that in these two items alone the British manufacturer is handicapped to the extent of 10s. per ton. It should, however, here be explained that the 5s. royalties (as before stated, in some cases it is more than 5s.) applies to British native ore, coal, coke, etc., used for manufacturing at works, and also to that consumed at ports of shipment by the engines taking ore to works and steel back for shipment, as well as to the bunker coal for steamers to convey it to foreign markets, where it has to come into competition with American steel, made unencumbered with royalty charges.

Ore Handling at Furnaces in America and Britain. At the most modern and up-to-date American furnaces, such as those at the Carnegie works, and other large steel producers, mechanical, hydraulic, and electrical labour-saving appliances which are in operation result in quick handling and great dispatch, and a less wage rate. These improved methods are to be seen in all directions. The ore is discharged at furnace stock piles from elevated railways, the trucks self-discharging the ore on to the deposits underneath by opening the bottom trap doors. Elevated, electrically-worked carriers, running on rails, collect the ore from the deposits to the pits connected with the furnaces. An inclined plane runs from the pits to the top of the furnaces—an arrangement similar to that of a "dredging machine," with an endless chain passing over pulleys at top and bottom, attached to which are the ore-charge carriers. These automatically fill themselves with the charge of ore in the pit, and an attendant in a cabin above, by touching a handle, puts the electrical arrangement in motion and the charges are moved up, another carrier at the same time coming round to fill itself; when the first carrier gets to the furnace top, the attendant touches another handle which lifts up the furnace top; by another touch, the charge is tipped in, and the furnace top shut down; the carrier returns empty, other charges being on the way up. All this is done in a few seconds, the coke and limestone being handled in the same way. Not a single person handles the ore from the pits to its delivery into furnace, other than a few men getting ready the coke and limestone for the elevator. Contrast this with the slow manual labour in the handling of ore and material at English furnaces—the shovel unloading of trucks, and the filling of the charges of ore, coke, and limestone into trams by manual labour—and the slower charging into the furnace! Snail motion, as compared with greyhound swiftness of American methods.

American Blast Furnaces. The most modern American furnaces are now made 100 feet high, with 22-feet boshes, as compared with British ones of 60 to 85 feet high with 18 to 20-foot boshes. American furnaces have numerous stoves to heat the air to a high degree, and use blast pressure up to 10, and even 15 pounds per inch to blow in this highly heated air. They have better coke, which will carry a heavier burden and costs less than British coke. They make their pig with from 16 to 18 hundredweight of coke to the ton of iron, their furnace output per day being 600 tons and latest furnaces 750 tons per day. Compare this with the English furnace output of from 100 to 250 tons per day, using 20 to 25 hundredweight of coke to the ton of

pig, having fewer stoves, air less heated, with a blast pressure of only 5 pounds per inch. The result is that the production of the up-to-date furnace is *three* to *five* times greater than that of the furnaces in present use in England. This results, of course, in a much less charge per ton for staff, wage, coke, and other expenses on a 600 to 750-ton output than on the 100 to 250-ton English output. It should, however, be noted that the 750-tons output American furnace, if working Bilbao ore containing 10 per cent. less iron, could give only about 625 tons output, or one-sixth less. Then something must be said as to the mode of the cast. The old British method is to run the cast into beds; when cold, men with sledges break up and remove the pigs and prepare the bed for the next cast, which is a laborious and slow process. The Dowlais Co., at their new and in a great measure up-to-date works, on the sea-board at Cardiff, pick up the bed of pigs by an overhead travelling carrier and take it away to be mechanically broken up and put into trucks, and have there also other labour-saving arrangements. They are also about putting down the "Morgan" American merchant-bar large-output patent mill plant, with other up-to-date machinery. So are also some of the works in the North; but with these few exceptions the old methods are the rule in South Wales, the Midlands, North of England, and in Scotland, at the present time. With so large an output as 750 tons per day, it would be simply impossible for the cast to cool and the beds to be prepared in time for the next cast. Various arrangements have been adopted to carry the cast of pigs away in pig troughs as made, one arrangement being a long endless chain, on which are pig troughs set close together. These pass over a pulley under the tap holes, and are then moved upward slowly on an inclined plane, the pigs cooling on passage; as it goes over the top pulley, the pig falls into a long tank of water, a chain in the bottom of which carires it forward over another upward inclined plane; again, as it passes over the top pulley, the pig drops into the truck. The metal runs continually into the pig troughs, which move on slowly to suit the filling of each, and the lips of the one incline to the next; this arrangement is manipulated by one man working the engine that moves the endless chain with its burden of cast pigs. Not a single labour hand is needed, other than the man arranging the tapping the furnace, from the time the metal runs out of furnace till it is tipped into the truck. Just imagine what this means in the saving of labour. No worry to the furnace manager to hurry up the men to get the cast beds ready or his metal will be out of the blast openings, to say nothing as to disputes as to wages, strikes, etc.

American and British Open-Hearth Furnace Methods. The latest mechanical labour-saving triumph is that of the Wellman-Seaver electrical charging and metal-removing machine, running overhead on rails in front of the series of furnaces, with an attendant seated in his cabin on the travelling machine to manipulate it. The up-to-date American furnaces have a smelting capacity of 60 tons each, and will be all in line, one superintendent being in charge of two furnaces, and one hand for each furnace. The travelling electrical machine picks up the prepared charge of pig iron, ore, or scrap, in suitable iron boxes of 10-hundredweight each, and runs it along to the furnace mouth; the attendant pulls a handle, and the furnace door is hydraulically raised; at the same time he touches an electrical switch and the charge is pushed into the mouth of the furnace, tipped, and the charging bar withdrawn; then he lets down the furnace door. The operator then runs back the machine for another charge for the next furnace, and soon, for the series. All this is done in a few seconds of time without the help of a single hand; no men are exposed to the terrible heat in charging these great furnaces. Then, for the removal of the tapped metal, the Wellman-Seaver electrical machine is the motive power. The metal is tapped from the furnaces in 25-ton, and even 50-ton, ladles; the electrical machine, worked by the attendant in his box, picks up the 25 or 50-ton ladle, runs away with it, and discharges it into the reservoir "mixer" capable of holding 200 to 250 tons of molten metal; then he returns for another 50 tons, all being done in a few minutes. When the contents of say five furnaces have been put into the "mixer," it is tapped out of the reservoir "mixer" into the ingot molds, thus insuring the cast of all the furnaces being mixed so as to be homogeneous, which might not be the case if each furnace was run separately into ingot molds. When the ingots are just sufficiently cool to be removed, these are again similarly taken up and carried on to the re-heating furnaces in the mills, and are here charged into and removed mechanically from the re-heating furnaces to rolls, and run out into rails, plates, or other shapes. For heavy plates, etc., hydraulic power is utilised to work the roll screws; the general practice in Britain is for the roller and several men to tug away and jerk the screws round, all being in a bath of perspiration from the hot blooms and the physical labour they have to perform, whereas in the modern American mill the roller is seated in his chair aloft and there mechanically directs the entrance of the bloom into, and its return through, the rolls. By a pull of a lever he puts the hydraulic machinery in motion to set the rolls to a nicety, till the plate is rolled to the required thickness. And

now comes a marvellously ingenious appliance, viz., that of an overhead electrical traveller with powerful magnets attached to chains manipulated by an attendant seated above. The chains with magnets are dropped down, and they pick up the heavy plate and run along with it to the guillotine shears. The top knife in this machine is fixed and the bottom knife is movable upwards, and by the pull of a lever the powerful hydraulic rams on either side underneath push up the knife, and the plate is instantaneously sheared. When large plates have to be cut to pattern, the attendants have simply to guide the plate suspended by the magnet to the shears. In the old-fashioned method, ten or twenty men would be needed to handle such a plate—more time occupied in doing the work, less dispatch, and much more wages cost. Another labour-saving arrangement is that designed to dispense with turning over heavy plates for inspection as to flaws and defects. The magnet carrier takes the plate over a recess room underneath the mill floor, where by electric light it is inspected from below. A further mill appliance is that of the Newbold rotary shears, capable of cutting circles, for boiler ends or other purposes, from 3-feet diameter to 11-feet diameter, and from ½ inch to 1¾ inch in thickness. When 12-feet-wide plates are rolled from which 11-feet circles are required, the useful magnet picks up the plate, after it has been cut square in the guillotine machine, and takes it to the Newbold rotary shears. The attendant places it in the powerful jaw of the machine, and the rotary cutter in the other jaw is set in motion; in two minutes the plate is cut into a perfectly true 11-feet circle; the magnet picks it up, carries it away, and piles it with others ready for delivery. Contrast this, again, with customary British methods requiring a great number of men to handle such a plate, having it chopped approximately near the circle, in the old-fashioned shears, and then carried to the mechanic in the boiler shop, who with his chisel chops it into a uniform circle; and it is at once seen what an enormous amount of manual labor, saving of time, and dispatch, are effected by the various mill equipments specified.

The mechanical equipment of the mills for a large output is such that the Illinois Steel Co. rolled out, in a day and night shift, the record quantity of 2,677 tons of rails.

Contrast, with the equipment just described, that of the British open-hearth furnace, which is usually one of only 20-tons capacity (as against the American one of 60-tons), with the proportionate extra consumption of coal to work three furnaces of 20-tons capacity, as compared with that used in the one 60-tons furnace. Four men are

engaged for each furnace. The same ratio of additional labour and coal costs continues throughout the British mills.

Let us now consider what the American can make his pig iron and finished steel at, and what it costs in England with Bilbao imported ore. It works out approximately as follows, at the average normal price paid for ore, coal, and wages per ton of 2,240 pounds:

BRITAIN, WITH BILBAO ORE AT 15S. AT FURNACE.		AMERICAN ORE AT 10S. AT FURNACE.	
Ore, 2 tons 50 per cent. to 55 per cent, iron, at 15s.	£1.10.0	Ore, 65 per cent., 1¾ tons, at 10s.	£0.17.6
Coke, 1 ton 5 cwt., at 10s.	12.6	Coke, 18 cwt., at 7s. 6d.	0. 6.3
Limestone, labour, coal, repairs, etc.	7.6	Ditto	0. 6.3
	£2.10.0		£1.10.0
Conversion into rails, bars, etc.	1. 5.0	Conversion	1. 0.0
	£3.15.0		£2.10.0

From the foregoing it will be seen that the American can make his Bessemer pig at 30s. and his bar and rail at 50s., whilst at normal prices for ore, coal, and wages, the cost in Britain to make the ton of Bessemer pig is 50s., and finished rail bar 75s. In 1900 when ore was 7s. 6d. more (and is 3s. 6d. higher at present), with double price for coal, coke, and higher wages, the cost at high-water rates was probably 100s. for pigs and 130s. for rails.

At present the Americans have to pay 25s. to 27s. 6d. per ton for rail and ocean transportation from works to European ports, which added to the works cost of 50s., and say 5s., for agency expenses, etc., brings the cost delivered in Britain and the Continent to £4.0.0. The Americans are now making arrangements to reduce the present transport charge to 15s. per ton, which would bring delivery down to £3.10.0; for instead of paying 7s. 6d. for rail rate to Baltimore and Philadelphia, and 17s. 6d. to 20s. to British ships, they will load their own 2,000-ton American built steamers at Conneaut Harbour, on Lake Erie, coming through the Welland Canal (which has been deepened to 14 feet) into the St. Lawrence, thus bringing the steel direct from works by water.* Several boats have already arrived by this new route, the only drawback being that the St. Lawrence is frozen for five months of the year; for that period shipments will have to come as heretofore. There is, however, at the present time, before Congress and the legislature of New York, a great scheme of making a gigantic canal, connecting the Lakes with New York, and tide water, through

* According to latest reports, this project has been abandoned for the present.

which ships of largest tonnage may pass to load products from the head of Lake Superior, and steel from Lake Erie ports, whence they will sail direct to all parts of the world. If this is done, it will mean a revolution in ship-building, for the Americans will at once build their steamers on the Lakes, with their cheap steel, and before the end of the next decade will come into competition and rival Britain for the carrying trade of the ocean, supplanting her present supremacy in shipping, as they have already done as iron and steel manufacturers.

Summarising the leading items of extra cost to make steel in Britain with Bilbao ore, we may put it roundly as follows:

5s. per ton extra for ore at Bilbao, for 2 tons to 1 ton of steel...	10s.
2s. 6d. per ton extra above lake rates for freight for 2 tons of ore	5s.
Royalties and wayleaves.....	5s.
Increased cost of coal, coke, increased labour charges for a less output, etc.....	5s.
Total, per ton of steel.....	£1.5.0

The British manufacturer, if he adopts all the most modern methods and appliances, and if the British workman falls into line with him by consenting to work in the various departments with the labour-saving electric and other machinery, may reduce the above extra costs by possibly 10s. But it is pretty evident that after knocking off the 10s., the American will in future still be able to make steel at 15s. per ton less than can be done in Britain with imported Bilbao ore at nominal rates; and with the contemplated reduced freights oversea, he will probably be in a position to compete even then with England in her home markets, and at 10s. to 20s. advantage in all other parts of the world.

It is with great reluctance and regret that I, an Englishman, have to make the foregoing very unfavourable contrasts between British and American methods in making iron and steel, and of the dilatory progression of my countrymen in the past. I wish it were otherwise, but the facts of the case need to be fully disclosed so that when realised, every possible reform in methods ensuring rapid production with a large output may be adopted; for it will only be by doing this that Britain will be enabled to make up for her want of foresight in the past in not forecasting the looming developments in America, and to put herself in better position to fight, on more equal terms, the American competition for trade which she has now to face unprepared.

My next paper will deal specifically with the things which Britain should do to better her position in the iron and steel industry and to check the wane of her ascendancy.

THE MECHANICAL EQUIPMENT OF THE SHIP-YARD.*

By Prof. J. H. Biles.

Ship-building is of pre-eminent interest, because it is the first and greatest industry likely to be affected by a shifting of the area of cheap steel production. Many other factors, of course, enter into the problem—labour conditions, acquired experience, economic and legislative policy. And these strong physical foundations of the industry—steel and machinery for working it most advantageously—are both purchasable on approximately equal terms by all buyers. It is not likely any artificial system, either commercial or political, can keep ascendancy in ship-building from crowning those who prove themselves most fit to handle the mechanical elements of the problem, most wise to establish firmness and stability in their political and commercial economy. It is to the former of these two requirements—the mechanical elements of successful ship-building—that Professor Biles' three admirably lucid articles will be devoted.—THE EDITORS.

IN these days of keen competition, not only at home but with foreign countries, the necessity of keeping abreast of the times in the matter of equipment is too evident to be dwelt upon at any length. Other conditions being the same, the cost of production will vary directly with the efficiency of the mechanical equipment; and modern improved tools capable of doing more work in a given time and often at less cost than the older types, together with labour-saving devices, or the substitution of mechanical for hand labour wherever possible, are essentials which will sooner or later determine the success or otherwise of an establishment such as a ship-yard.

The argument is sometimes heard in favour of old and obsolete tools, to the effect that they may have worked steadily for the last twenty years, and perhaps in their time have done good work, too, is scarcely a reason for their continued use; in fact, in many cases it is a potent argument in favour of the speedy substitution of newer and improved types. Recently, in America, new ship-building companies have been formed, which, unhampered by many old traditions, but nevertheless availing themselves of the benefit of accumulated years of

* The writer wishes to express his indebtedness to his former assistant, Prof. Sadler, and to Mr. John G. Johnstone for their assistance in the preparation of these articles.

experience from many countries, will have exceptional opportunities for adopting the latest and most efficient appliances for handling and working materials, and in the course of a few years will, without doubt, form powerful rivals to the old country.

The various tools or machines required in the mechanical equipment of a ship-yard may be roughly divided into two sections—those for handling and preparing the iron and steel work, and those for the wood work connected with a ship. The latter tools are practically the same as for any other wood-working manufactory, and beyond noticing that they must be provided in sufficient numbers in the proper place in a ship-yard equipment, they need not be further considered. A ship-joiner's shop is shown in Figure 1.

FIG. 1.—JOINER'S SHOP, C. C. SWAN & HUNTER, NEWCASTLE-ON-TYNE.

The former section of tools consists of two classes of machines:

1:—Those required in the various operations upon the material itself, such as angle bending, punching, shearing, planing, countersinking, plate-bending, plate-straightening, plate-planing, flanging, drilling, etc.;

2:—Those for assembling the various parts and for general handling of the material after it has undergone or while it is undergoing the above operations. This latter is a very important part, especially in

yards and where large vessels are being built. The distance that material has to be carried during the various stages of preparation, and until it is finally in place in the vessel, has a very important bearing on the time taken to construct a vessel and hence upon the cost.

This leads to the general question of arrangement of ship-yards. Few of the larger ship-yards in the United Kingdom are arranged in the best or most efficient manner for handling material. This is largely due to the fact that from time to time additions have been made to the equipment while the general manufacturing operations were in progress, and these additions have necessarily been more or less of a makeshift order. The yard has become a patchwork of equipment instead of a complete and homogeneous design. The important point to be borne in mind in the arrangement of the ship-yard is, that the material, from its entrance to the yard until its arrival at the building berth, should be subjected to the minimum amount of handling, and that the machines or apparatus for carrying out the various stages of its preparation should be placed in the natural order of the mechanical operations thereby involved, so that when the piece is finished it should be in such a position as to be transferred to its proper place in the vessel with the minimum amount of labour. The contour and amount of ground available, and the position of the building slips, especially where these must be placed at an angle to the line of water frontage to allow sufficient room for launching in narrow waters, considerably affect the general arrangement of the yard; but in all cases machines for each section of work of the ship should be as nearly as possible grouped together. All plate-punching, shearing, edge-planing, rolling, and countersinking machines should be collected together and arranged somewhat in the order given above, the last-named machine being as near to the building slips as possible, and the first near to the place where the material is stored on its entry to the yard. In this way, the material in the rough, while passing through the various processes to its finished state, is always tending towards its final position.

The iron work which forms the construction of the ship can be roughly divided into two sections.

1:—Framing.

2:—Plating.

1:—Framing. The equipment for making the framing of the ship is complete in itself. The framing determines the shape of the ship, and to obtain the required form full-sized moulds or shapes are necessary. These are obtained from a scrive board or floor upon which the exact form of every frame in the ship is drawn. Close to this board are

the iron slabs, which form a surfacing table upon which the actual frames of the ship are bent. Adjoining this surface are the furnaces for heating the material which has to be shaped, and also for punching shearing, and bevelling machines which enable the operations other than bending to be carried out. All these items of equipment must

FIG. 2.—SCRIVE BOARD NEAR THE FURNACES IN A SHIP-YARD.

necessarily be grouped together for convenience of doing the work and for efficiency of control. Figure 2 gives a view of the scrive board with some frames which have been bent lying upon it. To the left are seen the furnaces. In the background are the punching and shearing machines.

The lines which are put upon the scrive board are prepared in a place called the mould loft, the interior of which is shown in Figure 3. This is the place in which, after the ship's form is finally determined by the designer, the measurements of it, together with a few general particulars, are laid down. This is done to full size for breadth and depth measurements, but the length scale is usually contracted for sake of convenience in working and in order more accurately and quickly to fair the waterlines and sheer lines.

When the lines are fair the following particulars are transferred to the scrive board:—

1. Waterlines and buttocks (or vertical longitudinal sections) used in fairing.
2. Shape of every frame (port and starboard).
3. Deck lines giving heights in ship and lengths of beams.
4. Laps of plate-edges in shell plating.
5. Intersection of stringers, keelsons, bilge-keel, etc., with frames.
6. Knuckle line at stern. Height and form of bulwarks.
7. Tops of all the floor brackets.
8. Intercostals, etc.

The scrive board consists of deals, which are sometimes put together first on the mould loft by clamping them at the back in parts, and afterwards they are taken down to the vicinity of the bending slabs and furnace after the information has been transferred in the mould loft. Other times these deals are a permanant fixture near the fur-

FIG. 3.—INTERIOR OF MOULD LOFT, HARLAND & WOLFF, BELFAST.
Here were laid down the lines of the Oceanic and the newly-launched Celtic, the largest steamers now afloat.

naces, the lines being taken from the mould loft and scrived in on these fixed boards. The frames or angle bars, as they are ordered, should be stowed conveniently near the boards.

The first operation is usually to punch the frames. The holes are

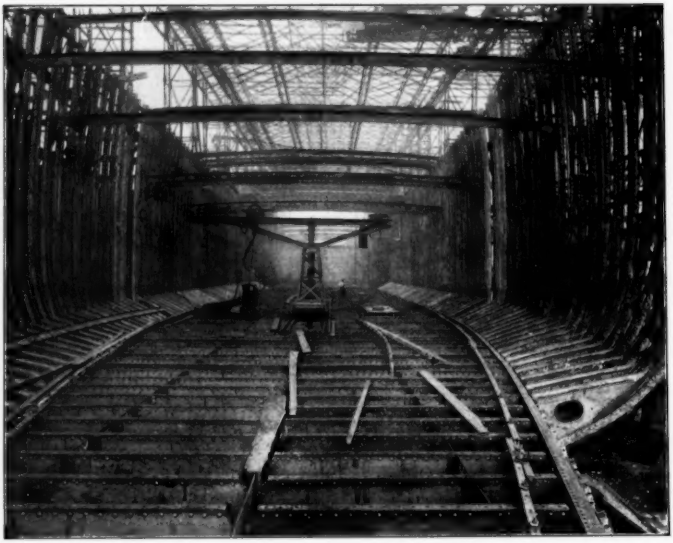


FIG. 4.—INTERIOR OF LARGE STEAMER, SHOWING FRAMING AND HYDRAULIC CRANE AND RIVETTER.

Ship-yard of C. C. Swan & Hunter.

determined by reference to the scrive boards, the information as to fixed position of laps, etc., being transferred by means of a flexible batten. After the frame is punched it is cut to its proper length and afterwards placed in the furnace. While heating, a set iron is prepared to the shape of the frame as laid down on the scrive board. As the frame is drawn out of the furnace, it is first bevelled either by the bevelling machine or by hand levers on the bending slabs, and if still hot enough, is bent and pinned to the mould of the set iron. If it is not hot enough for bending it is reheated. It is then ready to be taken to the building berth for incorporation into the framework of the vessel.

The beams form an important part of the framing. They are usually worked in a separate shed, near the scrive board. The holes are first punched, then their ends are heated in an open hearth and the knees formed. One method of forming this knee is to split the beam, open it out to the required angle, and weld a piece in the opening thus formed. The beams are then bent in a bending machine to the required round up; afterwards they are cut to the exact length and the knees

cut to the required bevel. The beams are then ready to be taken to the building berth.

When the frames and beams have been adjusted to shape, they are taken to the head of the slip appropriated to the building of the ship and the necessary rivetting operations are performed on the transverse frames. Each frame, as this is completed, is transported to its position on the keel and with its beam is erected or raised up to its actual position in the ship. The longitudinal framing is placed between the frames as they go up, and the whole is kept in place by wooden ribbands which are bolted to the frames. The ribbands fair the ship to the desired form, and the longitudinal framing is then rivetted to the transverse. During this operation the transverse water-tight bulkheads are being prepared on the boards, sometimes in a shed separated from the framing shed, and they are erected as soon as possible after the framing. They also help to fair the ship. Figure 4 gives an idea of the framing of a ship.

2:—Plating. On the form shown in Figure 4 is placed the plating, which forms either the sides of the ship or the decks, the outside or shell plating being attached to the frames and the deck plating to the beams.

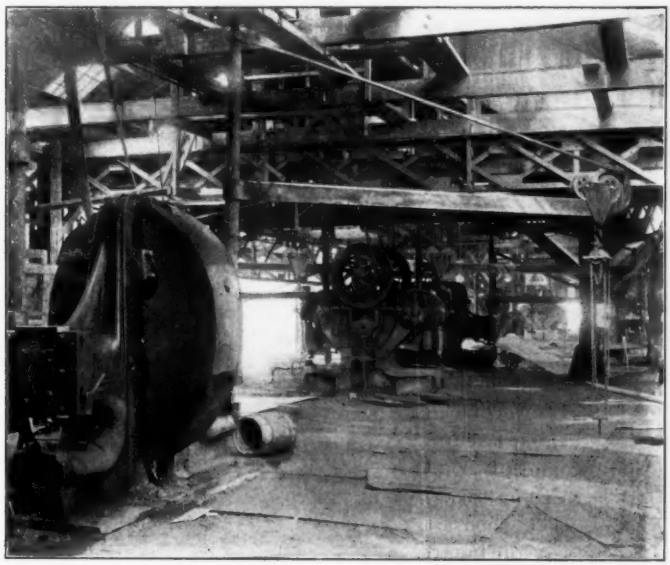


FIG. 5.—VIEW IN THE PLATING SHED.

These plates are rivetted to the frames or beams and the plating is caulked at its edges where necessary to make it water-tight. The operations of making these plates ready for rivetting are carried out in the plating shed, which is usually in one with the shed over the furnaces. Figures 5, 6, and 7 are views of machinery in the plating shed. Except in a few cases, such as plates at the counter, the plating does not require to undergo the operation of heating. The plates forming intercostals, bulkheads, brackets, etc., are worked first. For these plates moulds have been previously prepared at the mould loft, or their shape is taken from the scrive board. Shell or deck plates generally are not begun until the framing is well advanced and faired, though a few may be used for the process of fairing. A template for each plate is made on the framing to the exact size of the plate, and all the holes already in the framing are marked on it. This information is then transferred to the plate. The holes marked through from the template are first punched, then the plate is sheared, generally at the same machine as the punching, to near its exact size. Afterwards the holes are countersunk, the edges and butts planed, and the plate passed through either the bending or the straightening rolls. The last operation is to joggle the edges and ends if the system of joggling is employed.

The full details of the methods of obtaining the necessary information for the preparation of any given element of construction are

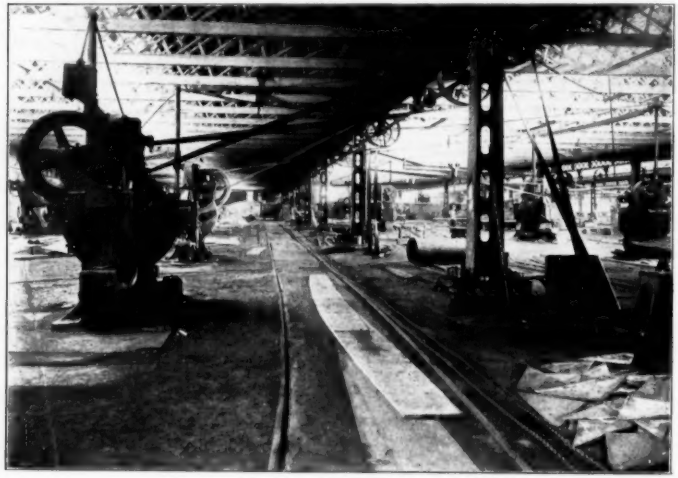


FIG 6.—FURNACES IN THE PLATING SHED.
Denny & Bros., Dumbarton.

FIG. 7.—PLATERS' SHED, HARLAND & WOLFF, BELFAST.
A plate being punched.

scarcely within the scope of this article, but in connection with this branch of the subject it may be noticed that a considerable amount of time and expense may often be saved by making as many parts as possible exactly similar. Carefully prepared templates of any special part can easily be made in the earlier stages of construction, which will allow these parts to be proceeded with concurrently with some of the earlier operations, instead of, as has often been the case, waiting until the construction had advanced to a later stage and then making a template from the vessel herself. The former system—of making as many parts as possible to one template, and using templates obtained from the mould loft for various elements—has reached a high pitch in the ship-building yards on the Great Lakes in America. In many cases the whole of the shell plating, deck plating, transverse frames, the chocks, keelsons, and inner-bottom framing which constitue the longitudinal framing for nearly three-fourths of the vessel's length, are prepared from a few templates, so that the process of building becomes one of bolting the various parts together. And if the work has been carefully performed no anxiety need be felt as to any parts not fitting properly.

What may be called the essential machines for the iron and steel work connected with a ship consist of those for punching, shearing,

planing, and countersinking operations. The first two of these, whether for use upon plates or angles, are almost always combined in one machine. The are driven either independently or by belts and shafting driven by an engine at a central station. Into the merits or otherwise of each system it is unnecessary to enquire here, as the circumstances in every case require special consideration, but where a number of these machines are grouped in one shed they may be driven by the latter means with advantage. The scope of a punching machine, as measured by the distance between the centre of the punch

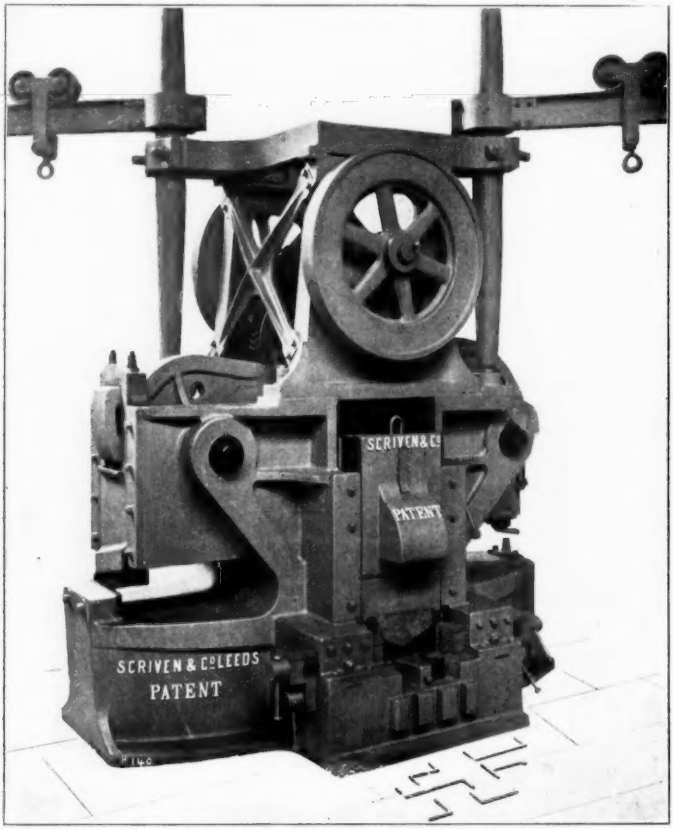


FIG 8.—PUNCHING, SHEARING, AND ANGLE-CUTTING MACHINE.
Punches 1⅛-inch holes through 1¼-inch steel plates 36 inches from the edge, and shears 1¼-inch steel plates 33 inches from the edge; has patent cutting arrangement for channels, tees, and angle bars.

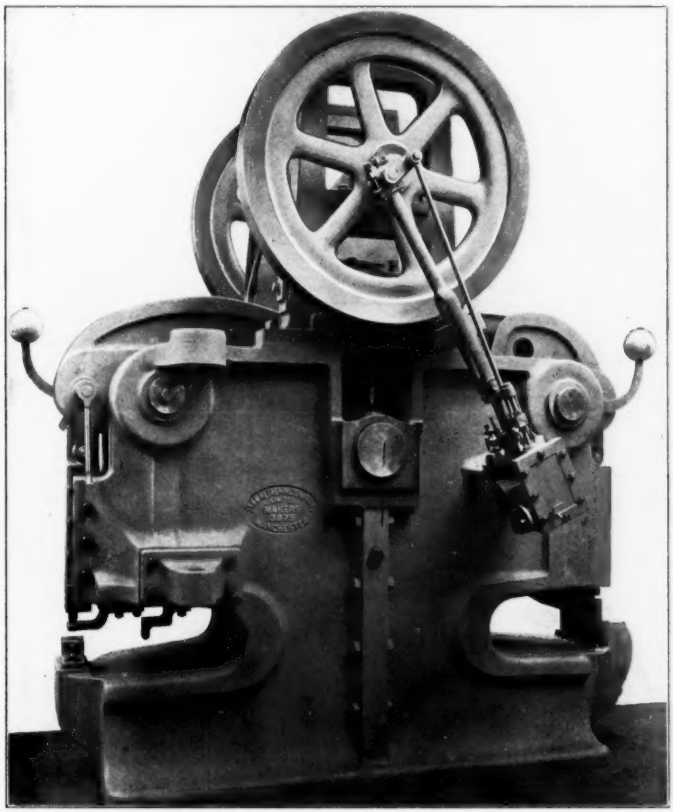


FIG. 9.—PUNCHING AND SHEARING MACHINE.

John Hetherington & Sons, Manchester.

and the back of the gap of the machine, has an important bearing on the cost of certain parts of a ship's structure, such as deck-plating, shell plating, etc. The width of plate that can be punched is limited to about twice the width of the gap, so that the number of strakes of plating is practically fixed by this factor, and in some cases the adoption of a wide-gap machine may lead to the reduction in the number of strakes in the shell and decks and to the consequent saving in rows of rivets, as each strake of plating saved involves the saving of the rivets in one edge of a plate.

The Punching Machine:—See Figures 8 to 17. The essential

parts of this machine consist of a punch and a die or hole, directly in line with each other, at the end of a wide gap. The punch is set in a strong slide which receives its motion from a lever worked by a cam. The motion is governed by a heavy fly-wheel on the driving shaft. A lever is fitted for disengaging the punch slide so as to bring it under the control of the workman, who guides the plate and only allows the machine to pierce when the part to be pierced is directly in line with the punch. A plate when being punched is held horizontally in the gap (Figure 7). The plate is supported by hooked chains from a

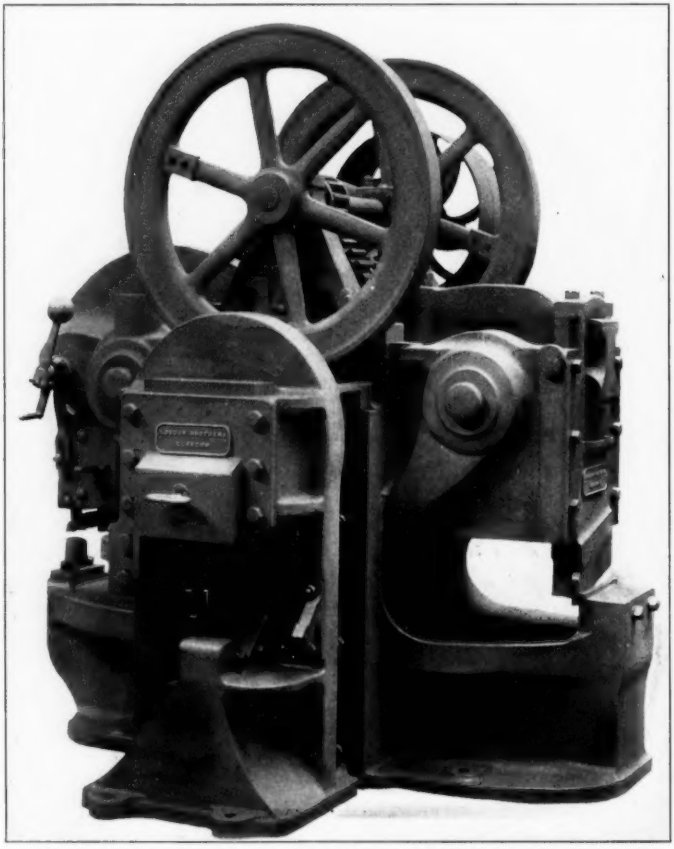


FIG. 11.—CAM LEVER PUNCHING AND SHEARING MACHINE FOR THE HEAVIEST CLASS OF SHIP-BUILDING WORK.
Loudon Bros., Glasgow.

runner moving along the horizontal jib of a crane attached to the machine, and free to turn horizontally. This crane is provided on all machines for punching and shearing plates. A large plate, how-

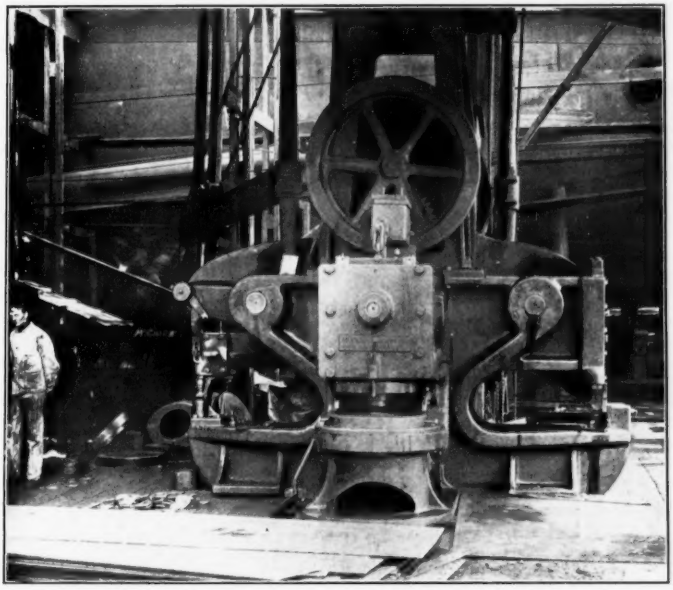


FIG. 10.—COMBINATION PUNCH, SHEAR, AND MANHOLE PUNCH IN THE UNION IRON WORKS, SAN FRANCISCO.

Bement, Miles & Co., Phila

ever, requires three or more workmen to guide it, one workman having control of the punching slide. Between each two strokes of the punch the plate is shifted. A point to notice here is that the cam which drives the punch slide is of the quick-return type, thus giving the advantage of having a longer time for changing the position of the plate from the moment the punch is clear of the plate until it again touches the plate.

Figure 15 is an example of the type of punching machines used for angle bars, etc. The chief features here are that the punch slide works horizontally and that no wide gap is required. The number of strokes per minute is regulated in nearly all cases from practical considerations—*i. e.*, the time taken after one hole has been punched to move the plate into position for the next. If all the holes are centre-punched in the first place and a tip punch used, the number of strokes per minute may be increased.

The Shearing Machine:—See Figures 8 to 14. The material is sheared between two steel blades set at an angle. The moving blade is set in a slide which receives its motion from a lever worked by an eccentric. This shear slide, like the punch slide, is provided with disengaging motion. When shearing a plate the plate is supported and worked in the same manner as when being punched. These machines have gaps of dimensions similar to those of the punching machines.

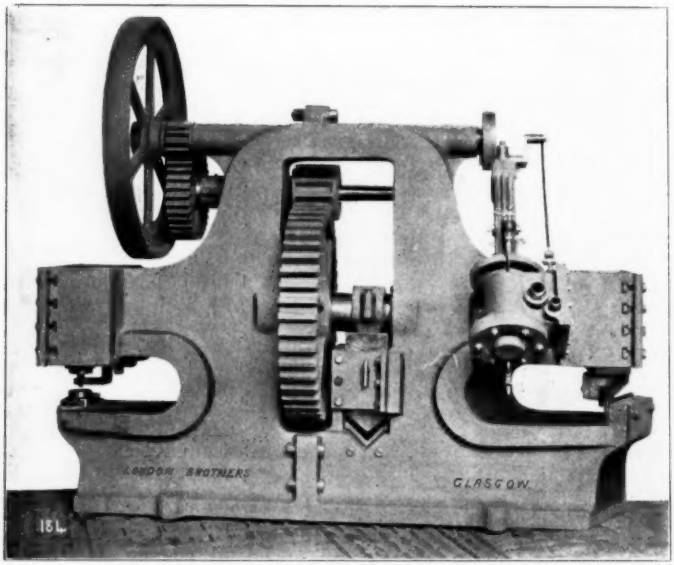


FIG. 12.—PUNCHING, SHEARING, AND ANGLE-BAR-CUTTING MACHINE.
Loudon Bros., Glasgow.

For cutting angle-bars, channel-bars, etc., the blades are designed so as to shear all the flanges at the same time. Examples are seen in the Figures 8 and 12.

Figure 8 shows a machine capable of punching 1½-inch holes in 1½-inch steel plates at one end, and shearing 1½-inch steel plates at the other end, 36 inches and 33 inches from the edge; it is fitted with disengaging motion to both punching and shearing rams. Provision is made, as in most punching and shearing machines, for two jib cranes, one on each side of the machine. Figure 9 is a machine of similar size but another type, being without the angle-bar cutting attachment.

Figure 14 is a punching, shearing- and angle-cutting machine, the angle-iron shear receiving its motion from an eccentric on the end of the main driving shaft. Figure 11 is another example of a punching, shearing and man-hole punching machine. In this illustration the jib cranes are shown in position. Figure 12 is a heavy machine with angle-iron cutter. Figure 13 is a similar machine, capable of punching 1¼-inch holes through 1¼-inch plate, of shearing 1¼-inch plates, and of cutting 6-inch by 6-inch by ¾-inch angle bars. The angle-cutter is specially arranged to allow for the angle bars passing through the body of the machine.

The addition of an angle-bar cutter to the punching and shearing machines may prove useful in special cases, and for small establishments, but where the plate and angles are worked in separate parts of the shed this fitting is superfluous.

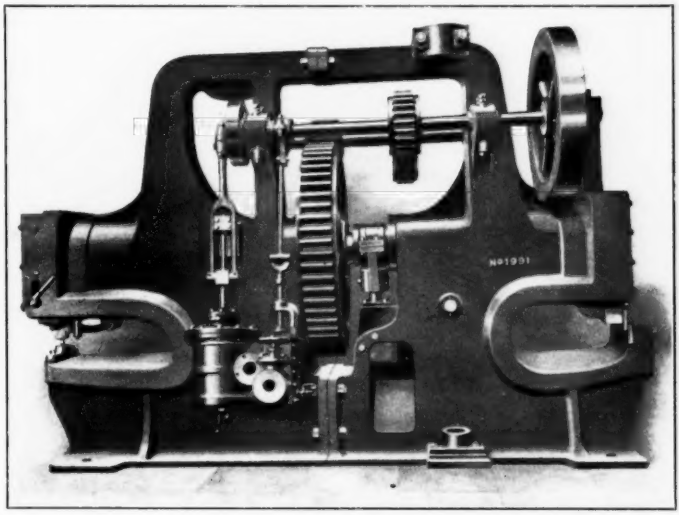


FIG. 13.– PUNCHING, SHEARING, AND ANGLE-CUTTING MACHINE

Punches 1¼-inch holes in 1¼-inch plate, 36 inches from edge; shears 1¼-inch plate 24 inches from edge; cuts 6-inch by 6-inch angles; driven by 10-inch cylinder engine. Craig & Donald, Johnstone.

Figure 15 is a combined beam or angle-bar bending and horizontal punching machine capable of bending or straightening up to 12-inch butterfly or 14-inch ordinary beams, of punching 1¼-inch hole through 1¼-inch plate; in other forms of this machine there are also, for cutting angle bars, two sets of shears at the centre (right and left)

capable of cutting to 10-inch by ¾-inch angle bar. It will be noted in these machines that there is no width of gap and that the motion of the punch is horizontal. This type is specially designed for angle bars. In other forms, it is made heavy enough to cut 12-inch by 6-inch by ¾-inch angles. The advantage of the bending or straightening attachment in Figure 15 effects a certain economy, as it saves moving the piece from one machine to another.

Figure 16 is a double-ended machine with twin punches. It is capable of punching, at each end, two holes 1-inch diameter through 1-inch thickness of steel plate, at each fall of the slide. The depth of the gap is 42 inches.

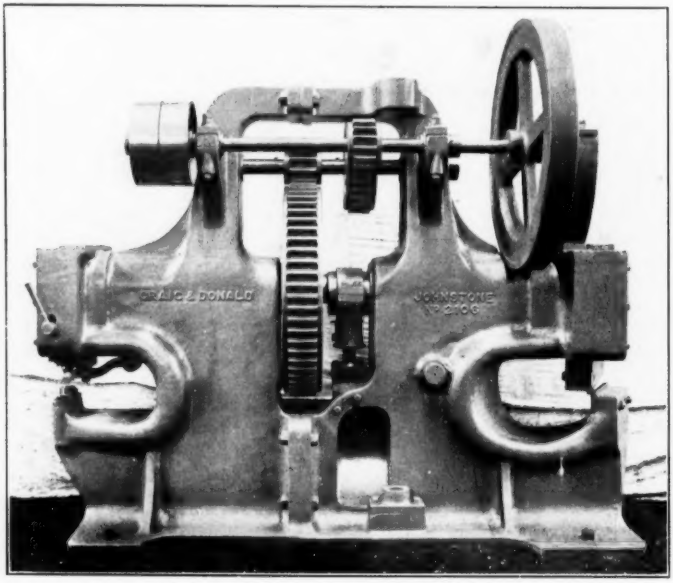


FIG. 14.—ANOTHER VIEW OF THE PUNCHING, SHEARING, AND ANGLE CUTTING MACHINE.

Figure 17 is a double-ended punching machine, having at the centre a side cutting or notching machine. The addition of this attachment is an advantage. The notching of the stringer plates in the way of frames involves a considerable amount of time if this is done by means of close punching, and as this machine is capable of notching any size up to 10 inches by 8 inches at one stroke, the saving of time by this means is evident. The figure also shows an arrangement

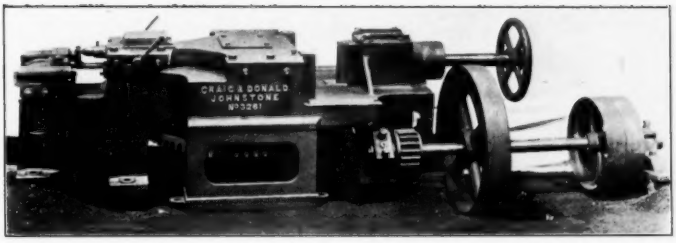


FIG. 15.—COMBINED BEAM-BENDING AND HORIZONTAL PUNCHING MACHINE.

Capable of bending or straightening 14-inch beams and of punching 1¼-inch holes through 1¼-inch plate.

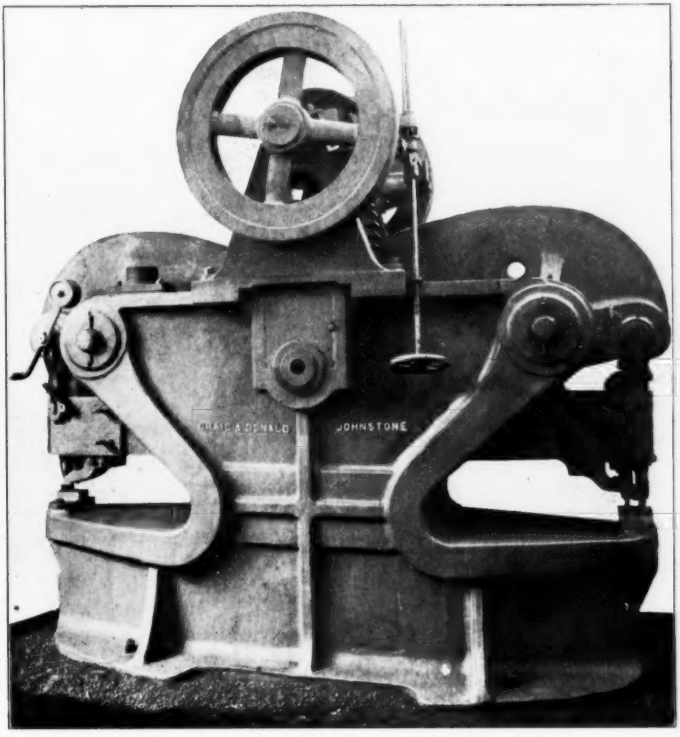


FIG. 16.—DOUBLE-ENDED TWIN PUNCHING MACHINE.

Punches two 1-inch holes at each end through 1-inch plate, or one 1½-inch hole at each end through 1¾-inch plate. Supplied to Clydebank and Denny & Bros.

for punching two holes at one time, but as there is an independent stop motion to each punch this machine may be used for single punching. The gaps at each end are 48 inches deep.

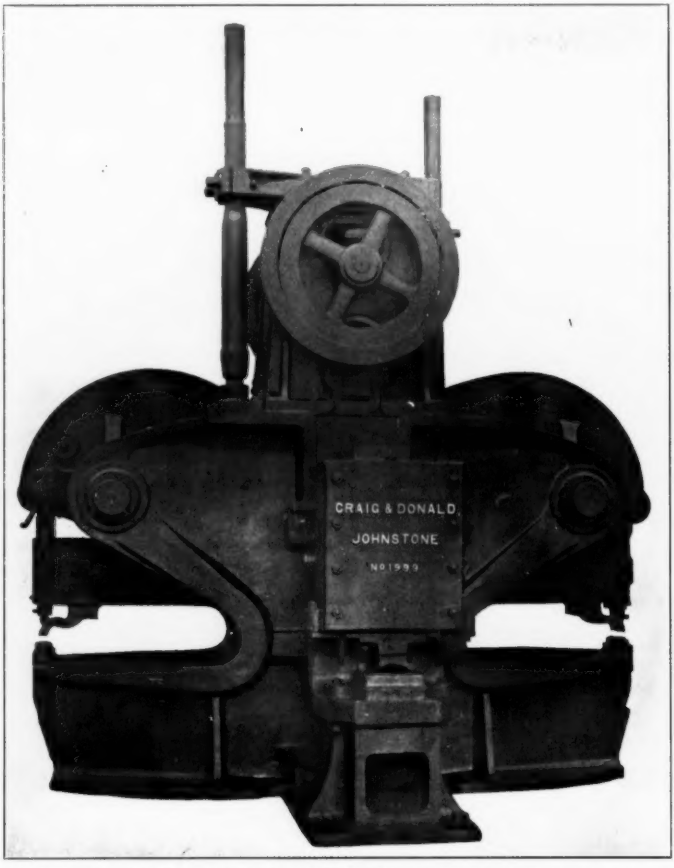


FIG. 17.—DOUBLE-ENDED TWIN PUNCHING MACHINE OF CAM AND LEVER TYPE, WITH SIDE-NOTCHING ARRANGEMENT.

Capable of punching constantly 1½-inch holes in 1½-inch plates, with both gaps 48 inches deep, and of cutting notches in stringer plates up to 10 by 8 by ⅞ inches. Crane posts are shown, ready for attaching suitable cranes.

Figure 18, on page 206, is an example of a small channel-cutting machine capable of cutting up to 8-inch by 4-inch channel bar. It can be arranged to cut an equivalent section of angle iron. The hand wheel

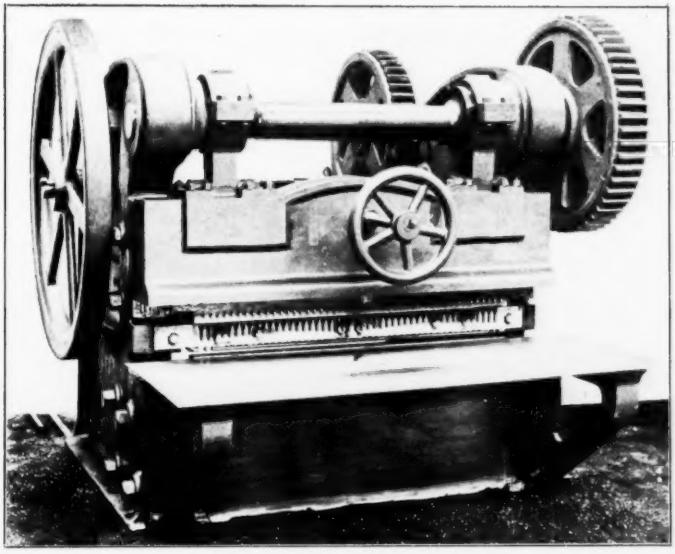


FIG. 19.—MULTIPLE PUNCHING MACHINE.

Punches 47 holes 7-16-inch diameter through 7-16-inch plate at one fall of slide. Will pass a 4-foot plate through. Specially adapted to ship-tank work. Craig & Donald.

FIG. 20.—MULTIPLE PUNCHING MACHINE IN THE PONTOON YARD, C. C. SWAN & HUNTER, NEWCASTLE-ON-TYNE

De Bergue & Co., Manchester.

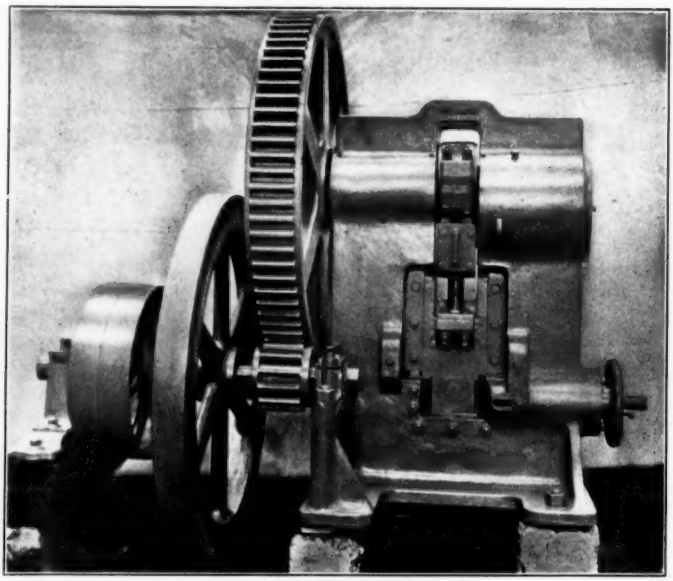


FIG. 18.—CHANNEL-CUTTING MACHINE

Cuts up to 8-inch by 4-inch channel iron, and can also be arranged to cut an equal section of angle iron.

actuates the side blades so as to vary the sizes of the cut for different sizes of channels that are used.

The multiple-punching machine (examples of which are shown in Figures 19 and 20) is not much used for ordinary ship work, although in long full vessels such a machine might prove a saving of time. It is used principally for tank work and for structures such as floating docks, where the spacing of the rivets does not change, as there is no change of form. If the construction of a ship be so arranged that most of the work can be done by templates, such machines will come to be of the first importance.

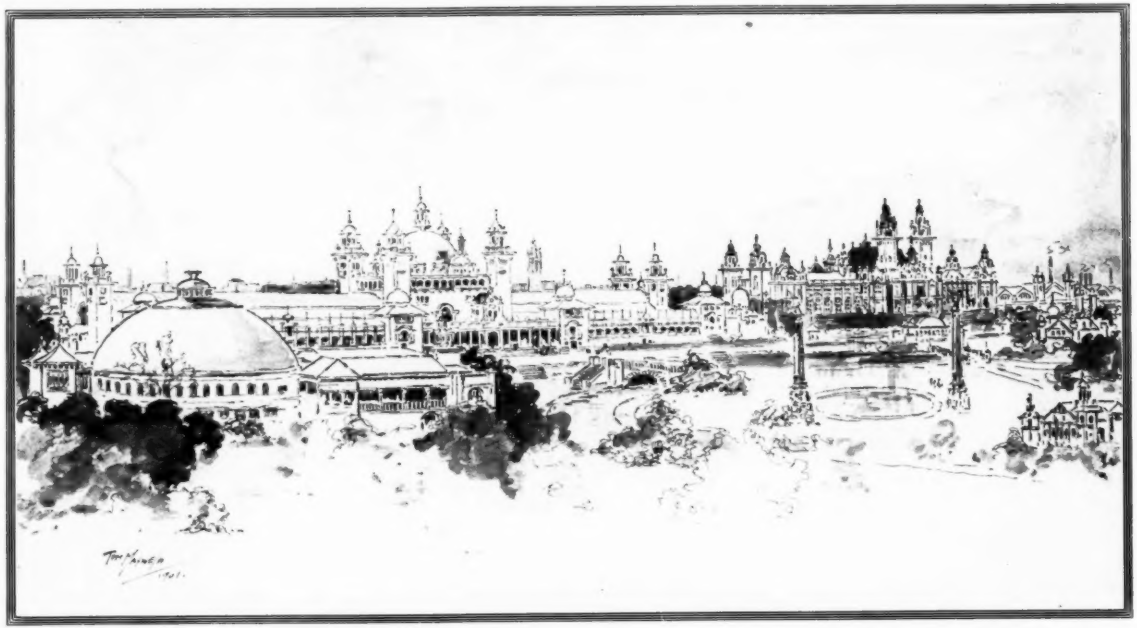
In the succeeding article I shall take up the larger tools employed more particularly in working the plating of a ship.

SCOPE AND SIGNIFICANCE OF THE GLASGOW INTERNATIONAL EXHIBITION.

By Benjamin Taylor.

The international exposition has always been an active influence in modifying and improving manufacturing methods. It takes on yet greater importance with the rapidly growing activity in engineering throughout the world, and with the concentration of interest on the mechanical processes and products which form so large a feature of the modern exposition. The coming summer will witness two great enterprises of this kind—one at Glasgow, near the heart of Britain's greatest steel-making and ship-building district, the other at Buffalo, in close touch with the same industries in the United States. The salient features of both will be reviewed in these pages later in the summer. Mr. Taylor gives below a summary of the most important portions of the Glasgow Exhibition.—THE EDITORS.

EARLY in May the International Exhibition at Glasgow will be opened, remaining open until November. It is mainly and essentially, though not exclusively, an Exposition of the mechanical and industrial development of the age, and is held in the second city in the British Empire, in the first year of the twentieth century. It is promoted, organised and administered in one of the busiest and most progressive industrial centres of Europe, by some of the most experienced and progressive mechanicians and industrial producers in the world. And in association with the Exhibition during the summer and autumn will be held at Glasgow the annual conferences of the British Association, the Institute of Mechanical Engineers, the Society of Engineers and Shipbuilders, the International Engineering Congress, the Institute of Naval Architects, and other technical and scientific bodies. Its avowed object is the display of the manufactures, natural products, industries, and material resources of all nations; of the machinery, plant, and appliances relating thereto; and of articles illustrative of science and art. But in especial it is intended to present a full illustration of the resources of the dependencies, dominions, and colonies of the British Empire, and the progress in industry, science, and art of *all* nationalities, during the nineteenth century. A broad indication of the scope of the Exposition is furnished by its scheme of division into the following chief classes: (1) Raw material, both agricultural and mineral;



Grand Hall. Dome and Grand Entrance. Fine Arts Building.

FRONT VIEW OF THE MAIN BUILDINGS, GLASGOW INTERNATIONAL EXHIBITION.

Specially drawn for THE ENGINEERING MAGAZINE.

(2) Industrial design and manufacture; (3) Machinery of all sorts in motion, electricity, and labour-saving devices; (4) Locomotion and transport; (5) Marine engineering and ship-building; (6) Lighting and heating; (7) Science and scientific instruments, education, and music; (8) Sports and sporting appliances; (9) Women's industries; (10) Fine arts, Scottish history, and archaeology. Some only of these sections come within the scope of this journal, and may call for detailed notice hereafter. The purpose of the present article is to give a general idea of the character of the undertaking, and some information about the structural and engineering aspect of the equipment.

The Exhibition starts with a guarantee fund of half a million sterling, raised by citizens of Glasgow. The Corporation of Glasgow provides the site—a fine one in Kelvingrove Park at the west end of the city, and just under the shade of the classic University, whose four hundred and fiftieth anniversary will be celebrated while the show is in progress. The site is practically identical with that of the Exhibition of 1888, and the two undertakings are associated by the fact that a surplus of £54,000 left by the 1888 enterprise was supplemented by the subscriptions of private citizens to the amount of £74,346, augmented to £250,000 out of municipal funds, and applied to the erection of permanent fine art galleries, which form part of the present Exhibition buildings. The area of the Exhibition buildings and grounds is seventy-three acres, and the grounds are intersected by the River Kelvin. The University buildings bound the area on the north, and the ornamental flower-plots, ponds, and fountains of the Kelvingrove Park are included in the grounds. The River Kelvin will be utilised for the exhibition of ship-building and life-saving apparatus, either in motion or stationary, although the reach which can be utilised for this purpose is comparatively short.

The buildings alone, which are from the design of Mr. James Miller, I.A., Glasgow, cover an area (inclusive of the permanent fine art galleries) of about twenty acres. Excluding these permanent galleries, which do not call for attention here, there are three main groups of temporary buildings, comprising the general industrial section, the machinery hall, and the grand hall for entertainments. The main or industrial section, with the grand dome in the centre, is 700 feet long and 330 feet wide, and covers nearly six acres. Through the centre runs the main avenue, 60 feet in width and about 70 feet high, having a circular-arched steel roof. This main avenue is not in any way divided by courts, and the whole space is an unbroken area. Steel was originally selected to be the structural material throughout, but when

the price advanced so greatly above what was contemplated when the plans were drawn, the building committee arranged for timber construction for large portions of the side and wing erections.

The general appearance of the buildings externally is Eastern. The architectural style is Spanish Renaissance, but with distinctly Oriental features lending to brightness and gaiety of colour. The leading architectural feature of the structure is the great dome, 200 feet in height, 80 feet in diameter, with four white towers each rising to a height of about 160 feet above the level of the grounds. Surrounding this dome, at a height of about 100 feet from the ground, is a balcony 400 feet in circumference and averaging 25 feet wide, forming a grand promenade, from which an extensive view of the grounds and of the city and surrounding country is obtained. This balcony is reached by spacious staircases and by powerful lifts in the towers. The grand entrance is situated under the great dome, and is led up to by an extensive peristyle, or colonnade, 200 feet long by about 80 feet wide, the floor of which is laid with white marble with an ornamental design in black. In front of the peristyle is a fine flight of steps extending the entire length of the colonnade. At each corner of the building, and on the north and south fronts towards the centre, are pavilions about 35 feet square, each having four lofty minarets at the angles, terminating with domical roofs.

In the industrial hall are the industrial and applied-art exhibits. In the machinery hall, attached to it by a wide curved and covered avenue, is all the machinery in motion and stationary. And in various parts of the grounds are special buildings devoted to the displays of France, Russia, Japan, Canada, Persia, Morocco, and other countries, and many others devoted to purposes of refreshment and entertainment.

America has not a separate section, but American exhibits occupy a large space in the machinery hall. Next to Great Britain, Russia is the largest exhibitor. M. Witte, Minister of Finance, announced to the Lord Provost of Glasgow the Czar's desire that Russia should be largely represented, so that "The participation of Russia in the Glasgow Exhibition will be a new step towards the establishment and consolidation of the amicable relations which are so important for both countries." So large were the demands of Russia for space that a section of the ground had to be set apart entirely for her requirements. The Government of the Czar made a grant of £30,000 for the erection of suitable buildings, and Imperial commissioners were appointed to prepare and supervise the Russian section—the first which Russia has

ever had at an International Exhibition within the United Kingdom. Over two acres are required to accommodate the buildings sanctioned by the Imperial Government. The four principal pavilions are devoted to agriculture, minerals, forestry, and the products of the Imperial estates. All are designed in old Russian style, and the ornamentation and other features are exactly as they appear to-day in the northern parts of the Empire. They were put up by Russian workmen sent specially from St. Petersburg, who worked for ten hours daily in spite of short winter days and bad weather, and with a short-handled axe as almost sole instrument. It serves for all kinds of jobs. After the original plans were passed it was decided to erect two smaller pavilions—one for a collection of grain from all the producing districts, the other for the use of the Millers' Association of Russia, also a grand reception hall for the use of distinguished visitors from Russia. In the industrial hall Russia has, besides, over 11,000 square feet of space, for a varied display of the country's manufactures and products. Russian industries will be shown in operation, and there are a Russian restaurant, band, choirs, and other national features.

So much by way of general view, and now let us look more particularly at the structure of the Exhibition buildings. These present many interesting features. In the case of the industrial hall, difficulty was at the outset encountered in obtaining a suitable foundation, owing to the treacherous nature of the ground covered by a building which will be so heavily loaded. The ground is mostly silt and mud, but at one place near the dome, rock rises nearly perpendicularly to the surface. A portion of the main towers and dome was founded on this rock, while the remaining portions are dependent upon the soft silt for their support. Thus special foundations had to be designed to prevent uneven settlement, and the remainder of the foundations were floated or spread over a sufficient area to secure this. On entering the interior one is struck with the light and lofty appearance, due to the judicious use of iron-work, which has been so designed as to give large uninterrupted floor space. The main avenue of the industrial hall has a roof span of 103 feet, which is contracted to 50 feet at the centre by the dome supports and adjoining four main towers. This roof is designed on the "three-hinged arch" principle, to counterbalance the expansion and contraction resulting from changes of temperature. The legs of the main trusses are hinged or supported on steel pins attached to steel bed-plates, which rest upon and are secured by means of bolts to the concrete foundations, the third hinge being placed at the apex of the roof, which is about 60 feet above the floor level. The main trusses

or principals are spaced about 40 feet apart, and, in addition to carrying the roof over the avenue, are saddled with the ends of the supporting girders of the side roofs, and resist the wind pressure against the face walls, which is taken up and conveyed through the girders to the trusses. Thus the stability of the immense structure is almost entirely dependent upon the strength of the central span, to which all stresses are conveyed. The principals are elliptically shaped on the underside, and formed of latticed steel work. A series of elliptically shaped open steel-work arches connect the principals along either side of the avenue, and give entrance to the side avenue. The roof is covered with glass and corrugated iron, supported by intermediate steel rafters and purlins, ventilation being provided on either side at the ridge for the whole length of the building. The side avenues are covered with roofs of timber of a novel design, and are remarkable for lightness. They are carried by timber girders extending from, and in line with, the principals of the main avenue to the face-walls. These roofs are also covered with corrugated-steel sheeting and glass.

The dome is covered on the outside with timber and sheet-iron, and internally with fibrous plaster. The whole framework of the Exhibition buildings is covered with fibrous plaster boards, faced with pure white stucco, and forming practically one piece. The corrugated-iron roof is painted to resemble red tiling. Green is also largely used for decorative effect, and the domes and minarets are gilded.

The industrial hall is connected with the machinery hall by the grand avenue, which by means of a roofed cantilever bridge crosses over the Dumbarton Road. This avenue has a length of 1,000 feet and a width of 75 feet. Its roof is formed of laminated timber ribs, semi-circular in form, spaced 15 feet apart, with a height of 40 feet above the floor at the ridge. It is covered with glass and corrugated-steel sheeting, the sides being enclosed with fibrous plaster secured to timber framing. The covered bridge over the public road is constructed of timber, and has a clear span of 65 feet across the road with a smaller span on either side. The bridge is supported by three main girders constructed on the cantilever principle. The cantilevers rest upon cast-iron columns, and the anchor arms are securely anchored and weighted with concrete blocks. The floor decking is supported by cross girders, and the whole is covered with a light timber roof.

By means of this spacious avenue we reach the machinery hall, in which most of the readers of this Magazine will find the greatest concentration of interest. A word, therefore, is due to its structure. It is erected outside the park and on what is known as the Bun-

house Grounds. To adapt these grounds for that purpose, and to give a level floor space, a large amount of excavation had to be done, and it was also necessary to construct a retaining wall to uphold the Dumbarton Road and a street. The machinery hall is 500 feet long and 320 feet wide. It is divided into a central and four side avenues. The central avenue has a span of 108 feet 6 inches, is covered by an arched steel roof of open girder work, supported by double columns placed eight feet apart and braced together by arched lattice girders. The columns, which are of steel, in addition to supporting the main roof and the adjoining side spans also carry a gallery with lines of shafting underneath, for conveying power to work the machinery exhibited. The columns, with the intermediate bracing, also resist the wind pressure from the side walls, which is conveyed to them through the roof members of the side spans. They are connected longitudinally by a double row of arched open girders of steel, which extend along either side of the central avenue from end to end of the building, and under these the gallery is carried by light lattice girders supported by cantilevers attached to the columns. The roof covering is similar to that of the other buildings. The gallery, which has a width of 16 feet, is carried right around the main avenue, and connects directly with, and is on the same level as, the floor of the bridge over the Dumbarton Road. Access to the floor of the machinery hall, which is 12 feet lower, is obtained by broad flights of stairs at either end of the hall. The side roofs of the hall, which have a uniform span of 53 feet, are supported by a series of steel latticed and tapered columns, connected by latticed box girders of steel. These columns and girders also carry lines of shafting for conveying power for working exhibits. The roofs of the side spans are of timber and steel. (For the technical details of this interesting structure I am indebted to the engineer.)

The dynamo house extends beyond the main building of the machinery hall at its southwest corner, and is formed by a continuation of the side spans of the main building. It is 100 feet square. The boiler house extends along the west side, is 204 feet long and 70 feet wide, and covers an area of 1,600 square yards. It is covered by a roof of one span of open timber work, and surrounded by a gallery from which the various boilers, economisers, etc., in use can be conveniently viewed. Sidings, with loading banks and electric and other cranes, are provided alongside the boiler-house and machinery hall, in direct communication with the Caledonian Railway system, for the delivery of exhibits, coal, etc., and a spacious covered way is extended from the

south end of the machinery hall to the platform of Partick Central Station for the convenience of railway passengers. Space is given by preference to those exhibits which will make the most interesting display and at the same time be of a representative character. The machinery will, as far as possible, be shown in motion, and, where practicable, actual manufacturing will be carried on. The machinery hall covers an area of five acres. The generating station is at the southwest end.

The motive power for the machinery on exhibit is supplied by four Lancashire boilers, 30 feet by 8 feet, working at a pressure of 120 pounds per square inch, made by Penman & Co., Glasgow; and installations of water-tube boilers supplied by Davey, Paxman & Co., the Stirling Boiler Company, and Babcock & Wilcox. The water-tube boilers are used to generate steam for the electric engines at 160 pounds pressure per square inch. Almost four-fifths of the power generated in the boiler house will be transformed into electricity by means of the following, and other, working exhibits: The Edison-Swan Co., Ltd., Glasgow; a 500-brake-horse-power Browett-Lindley engine and dynamo. Mavor & Coulston, Ltd., Glasgow; a 500-brake-horse-power dynamo with a Robey compound engine. Alley & Maclellan, Glasgow; a 300-horse-power compound engine, with a Mavor & Coulson dynamo. Hick, Hargreaves & Co., Bolton; a 300-brake-horse-power compound engine, and an alternator by the Lancashire Dynamo and Motor Co., Ltd., Manchester. D. Bruce Peebles & Co., Edinburgh; a 250-kilowatt dynamo, with a Belliss engine. Robey & Co., Ltd., Lincoln; a 150-brake-horse-power engine and dynamo, and a 70-brake-horse-power engine and dynamo. Wm. Sissons & Co., Gloucester; a 125-brake-horse-power engine and Clark, Chapman & Co. dynamo. There are also on show and at work two triple-expansion engines of 1,200 horse-power each built by Willans & Robinson, Ld., Rugby, for the electric-light station of the Corporation of Glasgow, each driving a dynamo.

Altogether, in the generating station there are twelve sets of combined steam engines and dynamos, giving a total of 4,176 electrical horse power at the terminals. Mr. Thomas Young, the courteous engineer of the Exhibition, to whom I am indebted for much of the detail in this article, informs me that it is intended that five of these dynamos shall work at a pressure of 500 to 530 volts at the terminals, and seven at a pressure of 250 to 265 volts. This range in the voltage is to provide for loss in transmission to the various stations or points of distribution through the various sections of the Exhibition. Three

of the dynamos are compound-wound, but all are used as shunt-wound machines, and coupled up to the bus bars of the main switchboard on the parallel system. Each dynamo is connected to the bus bars of the main switchboard through an automatic magnetic circuit-breaking switch, ampere meter, shunt regulator, and double pole. The main switchboard is also fitted with the necessary feeder logs, earth recorders, direct-reading and recording volt and ampere meters, electricity meters, circular-dial time piece, etc., and the sub- or switch distribution stations are seven in number, arranged two in the machinery hall at the northwest and southwest ends, one in the grand avenue, and three in the industrial hall. From these stations all arc and incandescent lighting is controlled. The incandescent switch and fuse boards are separate from the arc switch and fuse boards, both in the manner of erection and supply.

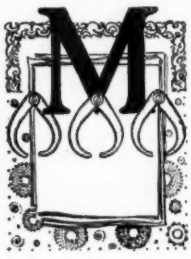
The exhibition will be lighted by means of Brockie-Pell 10-ampere arc lamps of various types, and incandescent lamps of various powers. In the main buildings, the arc lamp is adopted for general lighting, running 10 lamps in series on a 500-volt system; for all the other buildings the arc lamps are run 5 in series on a 250-volt system. The wiring of these arc lamps is so arranged that every alternate lamp is connected to a different circuit. In addition to the arc lighting of the main buildings there is also a complete pilot system of incandescent lighting, arranged so that if need arises all the principal passages, etc., can be lighted direct from the Corporation supply. The seven main cables are low-tension triple-concentric cables, insulated with impregnated paper and lead covered, laid in a wood conduit beneath the flooring between the main switchboard and the various sub-stations and switchboards, the total length being 4,000 yards. The branch main cables and sub-main cables are also laid in wood conduits beneath the flooring, or run overhead upon insulators, between the sub-switchboards and the distribution fuse boards.

Such, then, are some of the main features of what one may call the outfit of an Exhibition which, with many claims to attention on general industrial and popular grounds, will be chiefly memorable for its display of machinery. But of the contents of the machinery hall it is impossible to say anything in this article, except generally that they are representative of the engineering industries of the world. Marine engineering is a large and important section to which special attention has been given, and there is such a display of ship-building models, illustrating the progress of shipping in the past century, as has never before been brought into focus.

THE MECHANICAL ENGINEERING OF MACHINE TOOLS.

By Charles L. Griffin.

Prof. John E. Sweet, in an admirable address recently delivered, spoke of the growing accord of theory and practice. This means merely that both are becoming more enlightened—practice being based upon broader knowledge of laws and principles, theory formulated after more comprehensive recognition of all the conditions. When both are fully enlightened, there can be no discord between deduction and experiment. Empiricism disappears, and theorizing becomes practical. It is from this advanced standpoint that Mr. Griffin views machine designing.—The Editors.



ACHINE TOOL, taking the term in its restricted sense, signifies only a machine directly employed in the producing of finished surfaces on iron, steel, or other metals. Though dependent, like all machinery, upon fundamental mechanical principles, the class of machinery thus defined requires in its design and construction special engineering skill peculiar to itself. Many points rated as essential to success in machine-tool building are equally applicable to other forms of machinery. The refined character of engineering as evidenced below, however, both from mechanical and commercial standpoints, rates the machine tool as one of the most exacting pieces of machinery which modern engineers are called upon to produce.

Accuracy. The prime requirement of a finished surface is accuracy. This depends on the accuracy of the tool which finished it, and the accuracy of the tool depends on the accuracy of its own surfaces and joints. In other words, inaccuracy in the finishing tool will cause corresponding inaccuracy in the surface which it produces.

Manual dexterity by the toolmaker is essential to the production of true surfaces, but ultimate success is only assured when every facility is afforded him by the design, not only to produce a true surface, but to guarantee that it will stay true under conditions of use. This calls for a design of extreme stiffness, long wearing surfaces, strains taken in direct lines, firm and rigid supports, and careful adaptation to best modern shop processes. Accurate alignment and true surface, judged by the steam-engine, pump, or hoisting-machine standard, fall below grade when applied to the machine tool. Yet it is

good engineering to save such expense as unnecessary refinement will entail, and it is good design to figure on a grade of machine which corresponds to the grade of work it has to do. There is a commercial axiom, at least, which says that there is such a thing as building a machine too well, and the engineer who does not heed it is, in the present day of competition, out of the race. This same principle, which allows rough work on the steam pump and free fits on the engine, insists upon unqualified accuracy in the machine tool. Money invested in inaccurate tools is worse than thrown away; it is an investment which pays negative interest as long as the tool is operated. The manufacturer who designs and builds tools which produce curves when they should produce planes, and vice versa, is worse off than the buyer of them; in fact, his business must ultimately cease to exist. The keynote in the machine-tool business, to which all else is at all times tuned, is accuracy to the highest degree that modern skill can produce.

Rigidity. To attain rigidity in a machine tool requires the consideration of at least three fundamental elements of the structural design. These are: (1), Stiffness of frame or bed; (2), Mass to absorb vibration; (3), Number and construction of joints between the work and the bed.

Stiffness of frame is demanded to avoid springing under the strain of the work. On account of the universal nature of the tool, the strain is seldom capable of exact determination as to its magnitude, but almost always as to its direction and character. Therefore the correct distribution of metal into ribbed, box, or cylindrical sections should follow careful analysis of operation. Though no precedent be at hand to determine thickness of metal, close study of the severest conditions of service and good judgment will settle this point to a reasonable degree of success. Subsequent addition or subtraction of metal found necessary by experiment can readily be made by slight change in the pattern, provided the general plan of the structure be right, but not otherwise. Hence the necessity for correct analysis of form, if not of strength.

Concentration of mass close to the point of application of the work is on the same principle as the anvil between the blacksmith's hammer and the foundation. The absorption of tremor and vibration at the proper point by a sufficient quantity of material is the only guarantee of exactness in the work produced. Firm, solid foundations, though essential, cannot alone correct a vibrating and trembling machine. Experience seems to be the only guide for the determination of the

proper amount of material to secure steadiness, but perfection is possible only when based on truly scientific study of the principles involved. Correct deduction from experience is one of the highest functions of true engineering. The design of grinding machinery, in its full modern refinement, well illustrates this point. This class of machinery has very light work thrown upon it, but the high wheel speed, tending to vibration, and the exactness of size which must nevertheless be maintained in the work, make the element of steadiness of primal importance, so that the grinding machine is probably of greater weight in proportion to the work it has to do than almost any other tool. The marvelous accuracy possible with the modern grinding machine witnesses the success with which this problem has been solved.

Joints in a machine are unavoidable evils. Any joint which has motion between its surfaces, though carefully gibbed, must, of course, have some play or looseness for proper freedom of motion. The piling up of one slide upon another in order to secure various directions of motion integrates or adds up the looseness of the joints and endangers the rigidity of the machine. The knee of the universal milling machine, with its slides, swivel table, and platen, is an example of this piling up of joints, yet it has been refined to such a degree that it produces good work in spite of this inherent mechanical defect. The increasing use of the plain milling machine, however, on account of its few joints, simple parts, and general rigidity, is evidence that universality is always ready to be sacrificed to simplicity, when duplicate processes will warrant. Few joints, so arranged that the load of the work tends to press the surfaces together rather than to pull them apart, carefully gibbed, and fitted with scrupulous exactness, sums up the utmost we can accomplish toward the absolute elimination of undesirable motion due to joints.

Adjustment. Ability to keep an originally accurate and rigid machine perfectly in that condition until worn out, by taking up the unavoidable wear, is a requirement no other class of machinery has to meet to the same degree as the machine tool. To take up wear is easy enough, but to take up the minute increments of wear as they occur, without disturbing the exact alignment of shafts or the truth of surfaces, or binding or springing parts from their normal condition, is a more severe requirement. Wear cannot be entirely prevented, and the machine tool, as a machine of accuracy, is of no use unless the wear is adequately taken up. That the adjustment must be infrequent, and, moreover, attended to by a competent mechanic,

are the saving elements in the case, for perfect adjustment must of necessity be a delicate operation, though easy in the sense of accessibility and simplicity. It must be a positive, finely divided mechanism, and firmly locked when once adjusted. Ability to permit infrequency of attention is attained by ample wearing surfaces, and it is upon this one point alone that many machines excel. Though this is really dodging the issue, for to reduce the wear to an inappreciable degree is to dispense with adjustment, yet good engineering is as much the elimination of injurious action as it is the compensating for it when it is unavoidably present.

The protection of wearing surfaces thus becomes an element of adjustment, making advisable the application of guards, covers, and shields. These prevent metal chips, dirt, and other abrasive material from injuring surfaces or clogging the machine. Sometimes this feature becomes a special study, as in the case of the grinding machine already referred to. Here, not only the particles of emery from the wheel, but, in the wet type of grinder, the flow of water, which drenches the work, must be kept from the guiding surfaces. An inspection of a modern grinding machine will indicate the degree of ingenuity and skill with which these protecting devices have been worked out.

Lubrication. Good lubrication, a prime requirement in any machine, tends to be slighted out of all proportion to its importance. The method and detail of lubrication are too often worked out in accordance with space which happens to remain at the end of the design. The scheme of oiling then becomes an appendage, a patch on the machine, a collection of twisted pipes, pursuing tortuous courses to inaccessible bearings, or nobody knows where. The fault of poor lubrication may be laid almost wholly at the door of the original design. The fact that the operator allows his machine to run dry is inexcusable for him, yet in most cases the designer may be shown to have fallen far short of his duty to the machine and its operator in the scheme of lubrication. Proper oil caps can be provided, oil channels made ample and direct, oil pipes straight for ready cleaning, oil openings accessible and visibly indicated. While no machine can with advantage be built around a system of lubrication, yet it is possible so to keep in mind the future flow of oil to bearings and surfaces, that at all times in the progress of the design this element shall in a measure control their arrangement. If a bearing cannot be freely reached by oil, then it, or the obstructive member, must be re-located.

A fine, accurate machine tool is, least of all machines, the one upon

which to risk scanty lubrication. Expensive in first cost and repair, expensive in the delay its crippling causes, money invested in refined and positive oiling arrangement will return high rate of interest. If repetition of this were capable of impressing the importance of good lubrication more strongly upon those careless in this respect, then it should be a never-ending chapter with the subject begun anew on every page.

Convenience. A tool is an investment, the interest which it earns depending on the amount of work which it turns out in a given time. This depends largely on its convenience of manipulation, involving a study of levers, handles, wheels, knobs, auxiliary devices, etc., their shape and location with reference to best adaptation to the average human frame, the ease and extent of their motions, and the rapidity with which these motions may be accomplished. The position of the operator, his natural tendencies, the motions he will go through, all have to be imagined, in view of the attainment of maximum convenience. This study, in the absence of any counterpart of the proposed machine, often forces a resort to rough models, or in lieu of this, a full-size blackboard sketch, extending to the floor, upon which the location of parts may be tried for convenience.

This study of convenience is not a sentimental one. It is a strictly business consideration. A workman cannot be educated to use unnatural motions. A workman who likes his machine, who can handle it easily and with natural motions, will not only get the maximum amount of work out of it, but will himself constitute the best possible advertisement for its manufacturers. You never saw a workman who made a big record of work on a tool, who did not boast of it, not on the ground of his personal dexterity, but on the ground of his personal pride as operator of a fine machine. You never saw a workman who had to make a lot of false motions to operate his machine, and whose anatomy and limits of power and motion seemed to be totally inadapted to the tool in front of him, who did not curse it and its makers thrice over to any that might listen. Such negative advertisement does not always fall on heedless ears, and it is decidedly worth while, from a commercial standpoint alone to try a little "convenience" in the design to stop it.

The introduction of the ball-bearing upright in the radial drill, and the feed gear box on the lathe, are instances of legitimate and successful attempts toward increased convenience to the operator. True, they constitute time savers, but when originally brought out, their builders enjoyed special prestige because, from the selling agent

to the operator, the convenience and intrinsic worth of the device were at once apparent. This was not sentimentality; it was business. It was commercial machine tool design, a mechanical interpretation of convenience, redounding to the satisfaction of both builder and user.

Capacity. A universal tool implies capacity to take a wide range of work. It is manifestly unwise, however, to sacrifice stiffness, neatness and closeness of design, ease and facility of handling, for the sake of extension of range far beyond the average for which any particular size of tool is designed and best adapted by reason of strength, speed, or space occupied. Advertising purposes are often the sole object of such extension. The fact is that the manufacturer can build better, and the purchaser buy cheaper and to better advantage, if an extravagant attempt is not made to secure extreme range in any given tool. It is probably true that the experience of most tool builders has been to increase the number of sizes manufactured, and less and less to try to build ordinary machines for extraordinary work. However this may be, the planning and construction of a tool which can be handled with equal facility on all the varying sizes and classes of work within its range is no sinecure. Not only the average and common, but the special and unusual, must be provided for in universal tools. The ease and facility with which most of our common machine tools lend themselves to the finishing of difficult, special, and irregular shapes, is not accident. It is a forcible commentary on the past observation, ripe experience, careful study, and planning skill of the men behind the design. Credit is scantily given for such excellence, but criticism is freely furnished if a so-called universal tool, by its limitations, proves it to be absent.

Belt Power. Most machine tools are driven by belt, and the time is yet far off, if it ever comes, when the belt will be entirely superseded. Sufficiently wide belts to transmit the necessary power with comparatively low tension are conducive to long life of both belt and machine. An under-belted tool is reasonably sure at some time to have its belt pulled up to drive an increased feed and heavy chip, perhaps greater than it was designed for. However, there still remains something of a safety element in the limit to which the belt can be strained. The over-belted tool may drive itself to ruin unless provision be made for this by the introduction of purposely weaker parts to save the main and more expensive pieces. Perhaps the tendency nowadays is toward wider belts, with the idea that the user of the tool should be given the opportunity of subjecting it to overload at his own risk. This, it would seem, he is usually ready to take, and, to the

credit of the tool be it said, the attempt is almost always attended with success.

Direct Power. The mechanical-engineering status of the direct electric-driven machine tool seems to be based purely on the question of expediency. This status is not likely to be soon changed. The mere elimination of the belt does not seem to warrant the application of direct power in all cases. The possibilities in the line of simplicity, range and sub-division of speed, when associated with the elimination of the belt, are legitimate objects for accomplishment by the direct electric drive. The theoretical possibilities seem to be unlimited. Practically, the complication of the electrical controlling mechanism to secure required fineness of gradation is a difficult and often prohibitive problem.

Though the many good forms of the enclosed type of motor lend themselves readily to the service, yet that the motor and controlling devices may not be excrescences on an otherwise shapely tool requires considerable skill in harmonizing lines and method of attachment. The golden time when the motor and the tool shall not be the product of different shops, as at present, but shall both be wholly controlled by the tool builder, is the vision which haunts the present critic of the *ensemble* of the electric-driven machine tool.

Form and Finish. The general appearance of machinery viewed from a distance is the main criterion for judgment in most cases, except that of machine tools. In these we have a criticism of detail form and finish not applied to any other class of machinery. The general structure must, of course, convey the idea of solidity, but in addition, the careful detail of fillets, the rounding of corners, the shapes of handles and levers, the definition of bosses and lugs, the smooth regularity of surface, the finish of operating parts—all these and numerous other details must satisfy the critical eye. A single weak-appearing arm or support, though it be actually strong enough, injures the tool, and it is good policy of the builder to alter it to stop the criticism. These are not trivial things. A really good tool in other respects, but lacking in form and finish, will not sell and will not satisfy when sold. The American tool builder has won a world-wide reputation for the uniform and sensible style of his design, largely through the minute attention he has given to every detail. Aside from any other consideration, it should be a national pride to maintain and extend this reputation.

Trappiness. This coined term is used to signify a collection of details, insignificant in size, put together with a multitude of joints,

the whole device being, as the name suggests, a trap, a snare, a tangle of parts. Such a device is usually the result of a roundabout train of thought; it is therefore complicated, difficult to put together and take apart, not positive in action, its parts crooked and ugly—in short, the whole device constitutes a blotch on the machine, both in appearance and operation. The avoidance of this defect can only be accomplished by an absolutely clear and direct conception of results to be attained. Impractical inventions are often the result of blindly following an intricate and tortuous path, merely for the sake of preserving the invention, when simpler ways exist. When once the insatiable desire to invent something takes hold of a man, he is in a prime condition to produce trappy devices. True invention implies simplification, not complication.

Materials. The labor of finishing the component parts of a machine tool is apt to be the largest proportion of the total cost. Considering this, and the service expected of it when finished, the best material for the place is none too good. Judgment as to what is the best material involves consideration not only of the strength and stiffness of the proposed material, but of its wearing and tempering qualities, its homogeneity, its action under the finishing tool, available shop facilities, and the most advanced shop processes. For example, the milling process cannot produce satisfactory surfaces on castings of varying quality, full of hard spots, and of irregular size due to careless molding. The excessive cutter wear, the varying depth of cut, the jumping from soft metal to chilled spots, the trouble in maintaining the feed in such cases, are points which try the disposition of the workman and make uniform and good work impossible. Drop forgings, malleable-iron and steel castings, in their late perfection of quality, ought to be a special boon to modern machine-tool builders.

Standardization. Building tools in lots, a considerable number in a lot, is, of course, the only possible way to build cheaply and at the same time well. The opportunity here offered for the standardization of parts cannot be too early appreciated in the course of a business. For the proper application of standard patterns, jigs, fixtures, and cheap methods, this question of standardization will sooner or later confront the manufacturer. The earlier the demand is realized the better, for the herculean task of doing it all after the accumulated construction of a decade or more is vastly expensive, and accomplished at a tremendous disadvantage. Its feasibilty is then only possible on account of its undisputed necessity.

The original standardization of parts rests chiefly with the de-

signer, and on the consideration which he gives this matter is largely dependent his success and reputation as a practical man, alive to the interest of his employer and himself. It is not as pleasant or easy to design machinery of any sort with "hands tied," so to speak, to standard parts. The designer loves to let his personal fancy express itself without restriction. To be thus fancy-free is indeed ideal, but it is a luxury which must be paid for, and it comes high, and is therefore inconsistent with commercial interests. Ability to reduce designs to standard construction, allowing maximum shop production with systematic labor, and to reduce repairs and duplication of parts to the simplest system—this is true, practical, commercial engineering; the other is mechanical dreaming.

This idea of standardization applies equally to all classes of machinery. All modern refined processes tend toward it or imply its adoption. The screw machine, the turret lathe, the grinding machine, the multiple-spindle drill, and numberless other machines are all devices to cheapen and make better machine parts. For the full co-operation of these machines, however, they must be used upon standard parts, which may be produced in large quantities.

Conclusion. The mechanical engineering of machine tools involves not only mechanical proficiency, but a keen perception of the commercial and selling features of the business. Shrewd deduction from close observation, experiment, and long experience—such deduction based rather on true mechanical insight than on direct calculation—represent the attainment of the pure engineering faculty. This, it should be noted, is in contrast to the engineering involved in those larger mechanical structures, with more definite loads and service, not included in the classification "machine tools" as herein applied. In these larger structures an essentially different style of thought is predominant, a closer connection existing between the calculations of theory as laid down in the applied mechanics and the requirements of practice.

The mechanical engineer has a wide field in each and all of these diversified interests. It is due to his technical education, acquired in the engineering school, his observation and experience of actual practice, and his development of business sense, properly combined and conscientiously applied, that machinery of whatever class or variety—the machine tool or the locomotive—continues to improve, and will continue to improve with each succeeding generation.

GOLD MINING AND MILLING IN WESTERN AUSTRALIA.

By A. G. Charleton.

IV.—MINING METHODS, COSTS, AND SPECIAL CONDITIONS.

Mr. Charleton's series began in February. His preceding papers have dealt with topography, geology and general conditions, the dry-blowing process, and the water problems of the Westralian field. A concluding article will take up milling and cyaniding.—THE EDITORS.

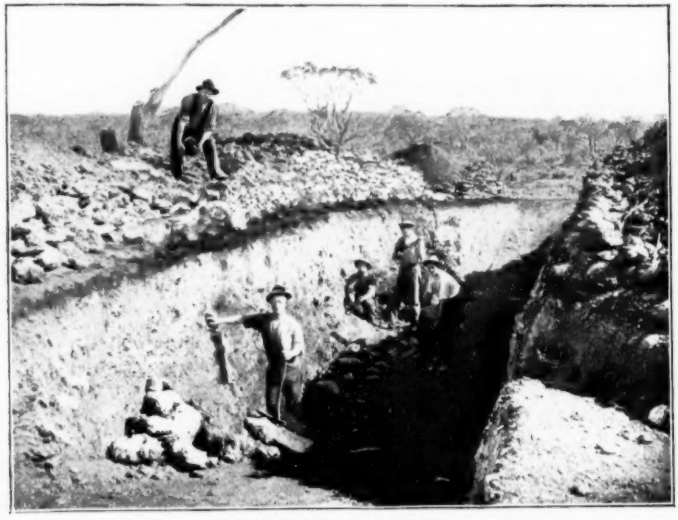
APITAL, in the early history of the Westralian field, was wasted in immense amounts in sinking small prospecting shafts, and leases of only 24 acres in area were frequently dotted with half-a-dozen or more shallow pot-holes, notwithstanding the fact that the lode-formations, as a rule, are almost vertical and the surface-zone is much unsettled. Consequently, even to-day, many properties are by no means as thoroughly explored as they ought to be. The leases held by any one company vary in size from 10 to 85 acres, but seldom exceed 50 acres.

A great deal of money may easily be squandered in objectless prospecting—for instance, in cross-cutting long distances where there are no indications to warrant outlay of the kind. But at Kalgoorlie there are a succession of parallel "formations," some of which are "blind-lodes" that never reach the surface at all; moreover, the ore in the different formations occurs in large isolated lenticular masses, containing perhaps individually thousands of tons of rich ore, separated along the course of the deposits by many feet of barren ground; the ore is also split up into vertical bands by parallel sheets or horses of country rock, and is liable to be faulted off or to be found in isolated bunches in the walls. Under such circumstances, before a lease can be said to be thoroughly tested it must be properly and thoroughly cross-cut at various levels. The length and direction which such cross-cuts should take is by no means arbitary, being governed by the nature of the discoveries made on the surface, or developments underground, and by the position of a property with respect to the formations discovered in neighbouring leases—in short, by indications and rational assumptions pointing to the probability or otherwise of finding a body of pay-ore in a particular part of the ground to be explored.

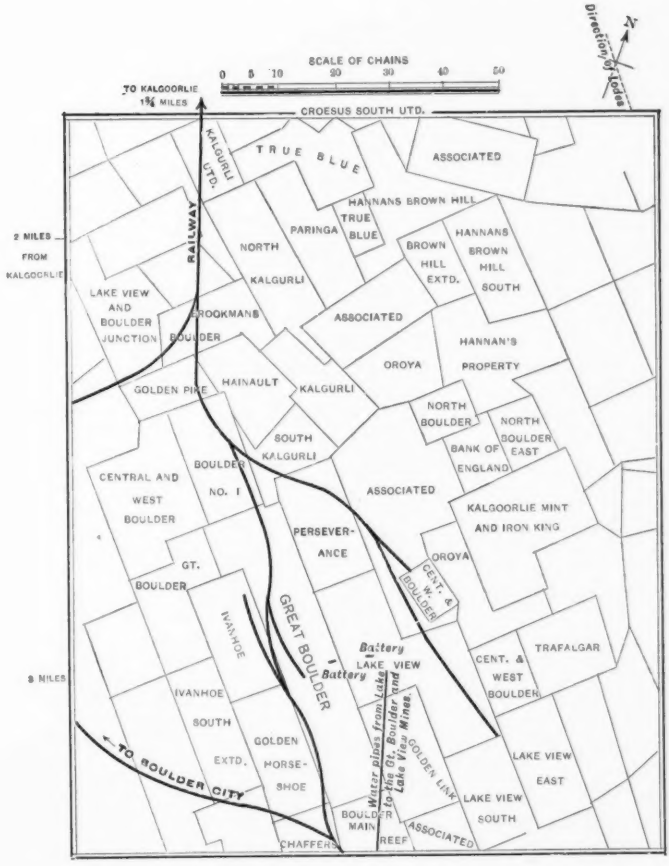
Where the width of a lease is considerable, it would seem to be the soundest policy, under ordinary conditions, to sink an independent prospecting shaft for cross-cutting the shallow ground, when looking for a formation; but if considerable depth has been reached, it would be cheaper, as a rule, to put out exploratory cross-cuts from the main-shaft when in search of a blind lode, or in order to see if (as has not unfrequently happened) any improvement has taken place in depth in a formation known to traverse the lease, but which has proved more or less barren at surface.

To avoid long and expensive cross-cuts and to save time, long single bore-holes are frequently run out with diamond-drills, to cross-cut the ground, and valuable discoveries have been made in this manner; but it is rather doubtful whether such a plan is always satisfactory or pays in the long run, since the results are sometimes misleading when a formation is intersected in an exceptionally rich or poor spot. You cannot examine a section of a bore-hole as you can a drive; and even if a rich formation happens to be discovered, time and money are lost in getting at it to open it up. The conditions, in fact, are totally different to those on the Rand and in other places, where deep exploratory bore-holes have been sunk no doubt with great advantage.

Probably no better system can be employed, however, at Kalgoorlie to test the ground on either side of a drive in a wide formation than that



AN OPEN CUT AT KANOWNA.



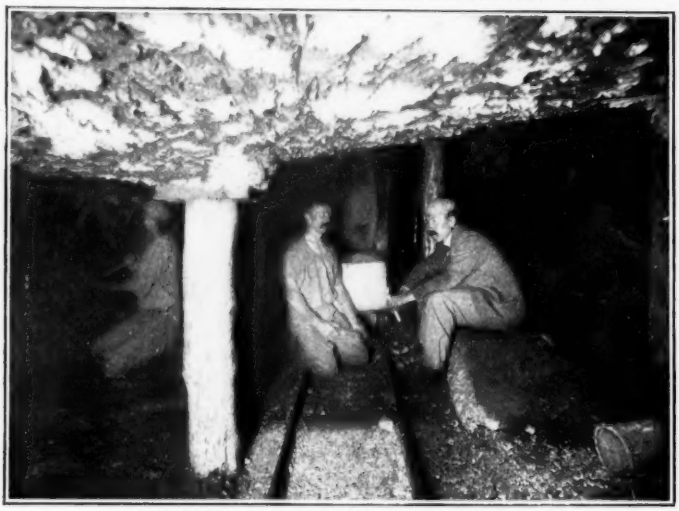
POCKET PLAN, SHOWING THE RELATIVE POSITIONS OF THE PRINCIPAL MINES, APPROXIMATE DIRECTION OF LODES, ETC., AT KALGOORLIE.

By H. Thiébauld de la Crouée. Reproduced by permission.

of putting in a number of short cross-cut holes for distances up to 100 or even 150 feet in length. As a case in point may be cited the new discovery reported in the Great Boulder, by a bore going west from No. 2 air-shaft on Robertson's lode; an oxidised ore-body was cut, reported to be 2 feet 6 inches wide, assaying 5 ounces. During the year 1899 the Great Boulder did no less than 4,802 feet of diamond drilling, and in 1898 1,250 feet.

Boring is done on day-pay and contract, the cost varying with the size of hole, nature of ground, price of "carbons," etc.;* but I believe about 20s. to 22s. a foot, depending on the amount of power supplied, will cover the cost of most of the larger size holes put in up to date; whilst under ordinary circumstances and under favourable conditions, small ones can be drilled for 5s. 6d. per foot.

Development of Shafts:—Baron van Oldruitenborgh expresses the opinion that a great mistake was committed by most of the mining companies at the start, by sinking nearly all their vertical or main shafts within the hanging-wall country of the lodes, to reduce the expense of cross-cutting, notwithstanding that this item in the cost of development is liable to increase constantly with depth, if the shaft is sunk in the footwall, unless the underlie of the formation changes. It is true that the former course is justifiable in most cases, but when, as at Kalgoorlie, the formations dip generally at a very high angle, no doubt it would have been better to sink on the footwall side.



WORKINGS IN AN ALLUVIAL CLAIM, KALGOORLIE

Whilst, on the one hand, the great width of some of the Kalgoorlie ore-bodies favours large outputs, on the other the uncertainty and irregularity in the distribution of the ore (more particularly in some of the formations) operates the other way, making medium outputs the rule, for the time being. Hence the powerful but necessarily

* "Technical Observations upon the Coolgardie Gold Fields." London *Mining Journal.*

costly installations for winding purposes which are common on the Rand would, even in its present stage of development, be money thrown away in Western Australia—a point which adverse critics of Westralian management seem to overlook.

HEAD-GEAR, SHAFT, AND DUMPS, GREAT BOULDER MINE.

The winding plant at the Great Boulder main shaft, Mr. Hamilton informs me, consists of a first motion horizontal engine, with a pair of 14-inch cylinders, 3-foot stroke, and 6-foot drums, steam being supplied by a set of 6 feet by 24 feet Cornish boilers. The pulley-frames or "poppet-legs," are of karri timber, the legs consisting of four single sticks of round timber, whilst the rest of the framing (which is 85 feet in height) is of sawn timber, carrying a landing-stage for the mine trucks at a level high enough to give good dump-room. At Lane's shaft the engine shed contains two pumps with compound cylinders, 9 inches and 16 inches diameter, and 12-inch water cylinders with a 15-inch stroke, which are used to pump the salt water required by the mine to the top of the hill behind the present mill.

I am indebted to Mr. Hewitson for the information that the Ivanhoe main shaft is equipped with an 18-inch by 42-inch first-motion engine, with 8-foot drums, and in the engine shed at Drysdale's shaft, which is fitted with an 8-inch Cornish lift pump, operated by an 18-inch by 42-inch engine, they have also a geared 12-inch by 30-inch

slide-valve engine with 6-foot diameter double drums. The head-gear at the winding-shaft consists of iron poppet-legs, 60 feet high, which were to be replaced by wooden legs 95 feet high; but I understand that the substitution of steel framework has since been decided upon. When tarred and set in solid blocks of concrete (a plan I introduced at Charters Towers, Queensland) wooden legs are perfectly safe from the attacks of white ants,, which are sometimes suggested as an objection to their use.

At the Lake View, the four posts of the main frame-work are set vertical and strutted with back-stays; but the legs of most of the head gears are spread outward, requiring no back struts with the engine set close to them.

As fuel and condensed water for use in boilers are both expensive items, high-pressure boilers are generally employed, and the exhaust steam is usually condensed either in galvanised-iron coolers, made of annular rings about 8 feet in height and 3 or 4 feet in diameter (a crude form of condenser) or in surface condensers of the Wheeler class. Lately, however, Fouche's aëro-condenser has been introduced.

At the end of 1899, the depth in feet reached by the principal main shafts as given in the *Statist*, were as follows:

Associated G. M. Co. Tetley's Shaft (Australia Lease), 500.
No. 4 Shaft, "Adelaide" lease, 700.
Chaffers, 500.
Golden Horseshoe, 505.
Golden Link Consols, 800.
Gt. Boulder Proprietary, 900.
Gt. Boulder Main Reef, 400.
Gt. Boulder Perseverance, 536.
Hannan's Brown Hill, 498.
Ivanhoe (Patterson's), 500.
Kalgurli, 420 ft. (winze to 520).
Kalgoorli Mint, 500.
Lake View & Boulder Junction, 607.
Lake View Consols, 500.
Lake View South, 768.

At the end of June, 1900, the Golden Link was down to 900 feet, and the Great Boulder Proprietary to 1,000 feet, these being the greatest depths so far reached on the field.

It must be confessed that, considering the age of the field, these results are by no means extraordinary, and some properties would undoubtedly have benefited by more energetic development in depth; but on the other hand, various mines have developed reserves of sulphide ore considerably in advance of their immediate requirements, and no doubt have been awaiting settlement of the water and sulphide difficulties before inaugurating a more active policy of development.

Interesting from a general mining stand-point as proofs regarding the permanency or otherwise of the telluride formations in depth might be, no doubt no one felt particularly anxious individually to face the

THE IVANHOE MINE, SHOWING HEAD GEAR AND DUMPS.

lions in the Stock Exchange arena earlier than was absolutely necessary, and not unnaturally everyone preferred to leave that honour to somebody else. Mr. Hamilton, of the Great Boulder, and other managers, however, with commendable nerve, acting under the conviction that the formations would hold down, led the way where others feared to tread, for which they are now reaping well-deserved credit.

Shaft Dimensions and Speed and Costs of Sinking. Mr. E. P. Simpson states that the main shaft of the Associated, 10 by 6 feet in

HANNAN'S BROWN HILL MINE.

section, was sunk 32 feet through hard diorite in one week, and I am told that the Lake View & Boulder Junction shaft was put down between the 200 and 520-foot levels at an average of 60 feet a month under Mr. Frank Grace, the best record being 44 feet in 12 days. These, so far as I know, are about the best records so far that can be shown; but, as a rule, it may be said speed in shaft-sinking is not very rapid when compared with the Rand,* and even with other places in Australia.

Whilst reasons that may account for this have already been explained, the slow rate of sinking is to some extent due to want of skill on the part of some of the men employed, few of whom possessed experience in machine work in the early days of the field. It is partly at-

ANOTHER VIEW OF THE GREAT BOULDER PROPERTIES.

tributable also to the blue ground probably being harder in depth than the Rand sandstone and quartzite formations; again, the comparatively small size of the principal shafts militates against record speeds. They are frequently (unless mere prospecting shafts, which are mostly 8 by 4) 10 feet by 4 feet inside lining timbers, and an ordinary contract price for sinking and timbering, covering labour only, runs about £5 a foot.*

It will however be seen that although the rate of sinking is slow,

* The rate of sinking in South Africa commonly runs from 60 to 96 feet per month, and as high a rate as 141 feet a month was reached in December, 1896, in the Vogelstruis deep vertical shaft. In a deep Queensland shaft I have myself made speeds in hard Charters Towers syenite, varying from 63 feet to 72 feet per month, timbered, at a cost of about £11.10.6 a foot, including everything. This shaft was laid out and started 14 feet by 3 feet 6 inches before I took charge; had it been a handier shape I think, moreover, the above speeds could probably have been exceeded

(and one reason for this has been that sinking and development have generally gone on concurrently) these small-sized shafts are far less expensive to sink and equip than those on the Rand, where many of the main shafts cost from £15 to £31 per foot, and more—an outlay justified in that case no doubt, however, by the paramount necessity that exists to provide for a large output, to open up a large area of ground in depth from a single shaft with the utmost possible speed, to provide space to allow of proper ventilation in depth, as well as to give room for air-pipes, etc., in the pump and ladder-ways.

Some of the West Australian shafts, like those I have referred to, are "box-lined" for the sake of cheapness, like most Queensland shafts; in other cases, as at Lake View, where the ground is perhaps heavier, square-set timbering is used, with "lagging driven behind the wall, and end plates."

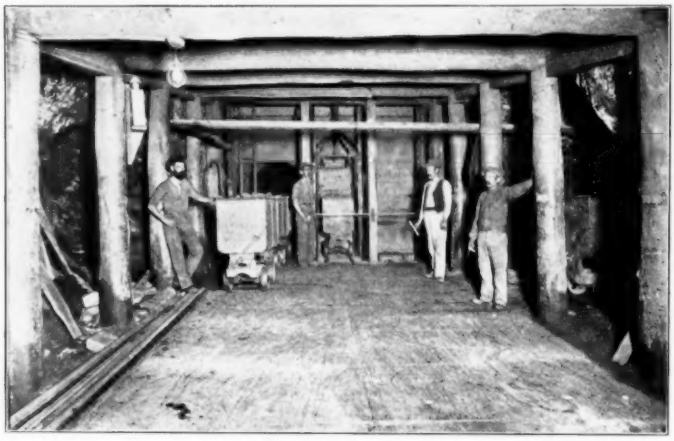
There are no underlie shafts at Kalgoorlie, owing to the vertical dip of the formations.

Shaft Equipment:—Owing to the small size of the shafts, the average weight of ore raised at each hoist is only 7 cwt., as compared with 4 to 16 tons hoisted at one operation at Johannesburg; in Australia the hoisting is commonly done in cages. There is no doubt that this method of hoisting possesses distinct advantages in collieries, but in metal mines it is questionable whether in a suitably arranged shaft, with underground plats for storage, preference should not be given to self-dumping skips, holding 3 tons or more, such as are employed on the Rand; they save weight and the services of brace men. They can be carried on frames running along the shaft-guides, and a common size in Johannesburg is about 30 cubic-foot capacity. One advantage also of a skip-road is that a water-tank can be employed for bailing, if there is no great quantity of water to be raised.

The single-deck cages carrying the trucks are fitted with the ordinary safety appliances and with hooks to prevent overwinding, and are balanced in the two hoisting compartments of the shaft by leading the winding ropes over one drum of the engine and under the other. The end-tipping steel trucks used underground measure in some cases only 8 cubic feet (holding 6 or 7 cwt., with a tare of about 2½ cwt.); in other cases they hold 10 cwt., and at Great Boulder they have a capacity of 13 cubic feet, which from the point of view of economy in haulage and transport is a step in the right direction; the pattern I saw in use, however, in one or two mines, struck me as somewhat cumbersome, and likely to give trouble if a truck became derailed in a level.

At the various levels, plats are chambered out the height of the

opening-out set for the full width of the long side of the shaft, and carried straight in, or sloped up from the drive, which is commenced about 20 feet or so beyond. The floor is boarded and covered with flat-sheets, and they are lighted in some cases with electric glow lamps, and in other cases, as at Great Boulder, with oil-lamps. Plats of this kind cost about £7 a foot to drive. Pumps are but little needed, it being generally possible to dam back most of the water which comes from the surface in the upper levels, and syphon it off into skips or water-tanks. Nasty sores are caused if men are much exposed to the salt underground water.



PLAT, 200-FOOT LEVEL, LAKE VIEW CONSOLS MINES.

Air-Compressors and Rock-Drills:—In the soft upper ground, hand labour was necessarily extensively employed. In the hard igneous rocks, machine work is however undoubtedly not only the cheapest but a necessity if rapid progress is to be made, although the schistose and jointy structure of the rock at times gives trouble with the drills "fitchering." These facts explain why the introduction of machine work on the field has not been more general and rapid.

The ordinary air pressure used at most of the mines varies from 70 to 80 pounds per square inch, but there seems no reason why, given suitable machinery, higher pressures of 90 to 100 pounds should not be employed to accelerate speed.

Rand 3⅛-inch and Ingersoll-Sergeant 3¼-inch drills are most in favour on the field, the latter giving very satisfactory results; but Mr.

Hamilton informs me that at the Great Boulder they use both Ingersoll-Sergeant, and Bendigo 3¼-inch machines, and find them equally efficient. I have no information as to where the Climax, which is largely in favour in India, or other types of drill in use elsewhere, have been tried. Compressed air is used to operate air winches and small pumps underground at times, but pumps are expensive to operate in this way.

Drives and Levels:—In most of the mines the levels are run 7 by 5, and are driven at intervals of 100 feet or less, connected by rises and winzes, passes 4 by 4 in the clear being put up about every 50 feet, timbered with 8-inch by 2-inch sawn timber, and closed at the bottom with sliding doors.

In machine drilling, about 18 holes are drilled in the face, to a depth of 4 feet or so, the centre ones converging, and the outer ones radiating at an angle outwards, so as to square-up the face, in the usual manner.

MACHINE DRILLS AT THE FACE, 200-FOOT LEVEL, LAKE VIEW CONSOLS MINES.

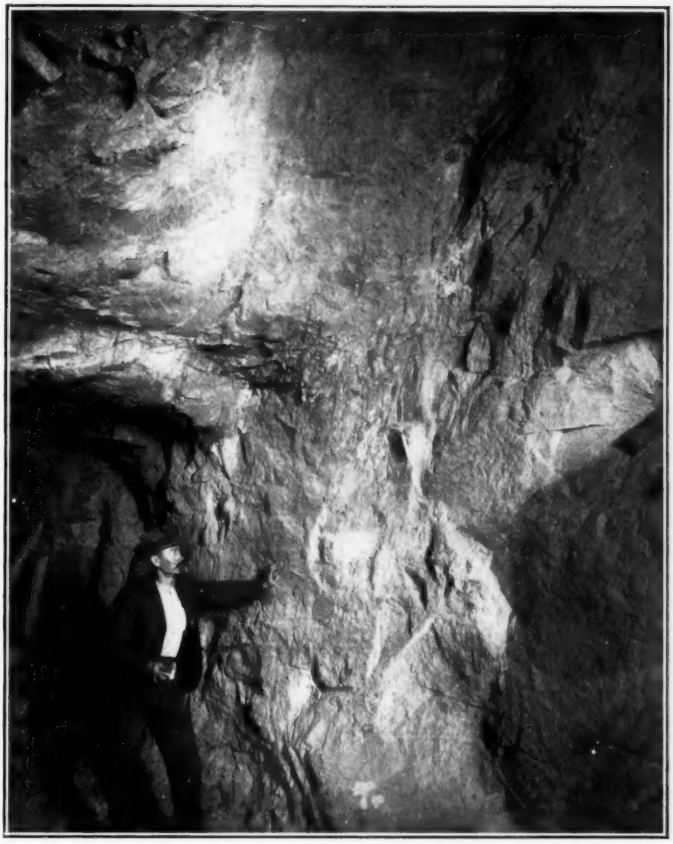
3⅛-inch and 3¼-inch star or cross bits are used in driving on the lode, and chisel-edge bits in cross-cutting. The employment of machine-drills increases speed, but according to various managers makes little difference in cost per foot.

The cost of driving levels in the softer oxidised formation by hand may be ordinarily reckoned I believe at £1.5 to £1.15 per foot, though it can sometimes be done for less than 20s. In the lower levels the cost of driving with machines at present comes to about £2.10 per foot, including explosives and sharpening drills. At one mine, according to Mr. H. F. Bulman*, they give a bonus to each man of £1 per week if 16 feet is exceeded, whilst at another £2 a foot extra is paid for rates exceeding 19 feet a week. Drives of ordinary size, 7 by 5, used to cost £2.5.10 to £3.6.8, according to Bancroft, whilst Hoover figured the cost of driving and cross-cutting in 1898 at from £2 to £6. Mr. Bulman states that a cross-cut 7 by 5 was driven 40 feet in a fortnight by 6 men (2 per shift) with machines, doing their own trucking to the shaft, 500 feet. He adds that in levels in hard sulphide ore, 12 feet a week is considered a fair rate of speed with 3 pairs of men, drilling by hand.

I am told by Mr. Hewitson that at the Ivanhoe Mine they reckon 85 feet an average rate of progress per month in levels driven with machines. Mr. Hamilton, of the Great Boulder, puts the average length of holes drilled per shift at about 50 feet, varying with the rock. It will be seen therefore that the speed of driving, as might be expected, compares more favourably than shaft sinking with the Rand, where the average rate of progress in driving levels is something over 100 feet a month, but existing rates might probably be improved upon in Kalgoorlie by adopting a squarer section of drive with its greatest width in the middle, and giving greater attention to the method of placing the holes, so as to obtain the same effect with a smaller number, say 14, the face being apt to be burnt instead of blasted out, if an excessive number of holes are put in. Mr. Hoover reckons that the cost of driving in Western Australia (presumably including everything) varies from £2 to £9 per foot, of which about 80 per cent. goes for wages.

Explosives:—These consist, according to Mr. Hamilton, of Nobels Glasgow gelignite, blasting gelatine, gelatine dynamite, and red dynamite. They cost from £3.1.6 to £4.8.6 a case, nearly double Glasgow prices *plus* freight. There is said to be a ring in dynamite, although it certainly costs less than in South Africa, where the dynamite monopoly has long been a notorious scandal and grievance.

* Trans. Inst. of Mining Engineers.

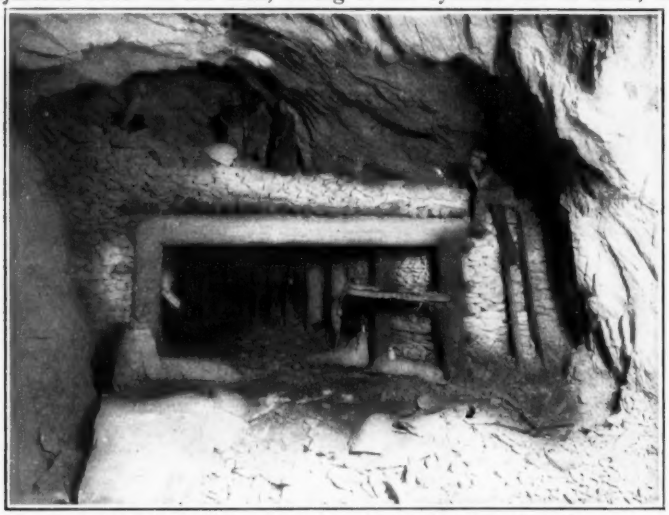


LAKE VIEW CONSOLS. FACE OF RICH TELLURIDE ORE, 300 FEET.

Timber:—Good mining timber is very scarce; and whilst native woods such as jarrah and karri, which are found along the coast, are largely employed underground, more particularly if required in long lengths, for various reasons they are not so much used for general purposes as Oregon pine, which costs about £12 per thousand, delivered along the railway. The native woods are brittle, double the weight of pine, shrink greatly, and are very difficult to work, carpenters' tools requiring to be specially tempered for the purpose.

Stopes:—Overhand stoping and rock filling is the method almost

universally employed in removing the ore, but it is more than probable that in the wider ore bodies a considerable saving in expense might be effected by cross stoping them, on one of the systems employed in mining very wide deposits. The only novelty in practice in this respect that has come under my notice is the plan that was first adopted at Lake View, of running the waste tailings from the cyanide-vats through surface passes into the stopes for filling. At first this produced a very injurious effect on the men, owing to the cyanide left in them, the

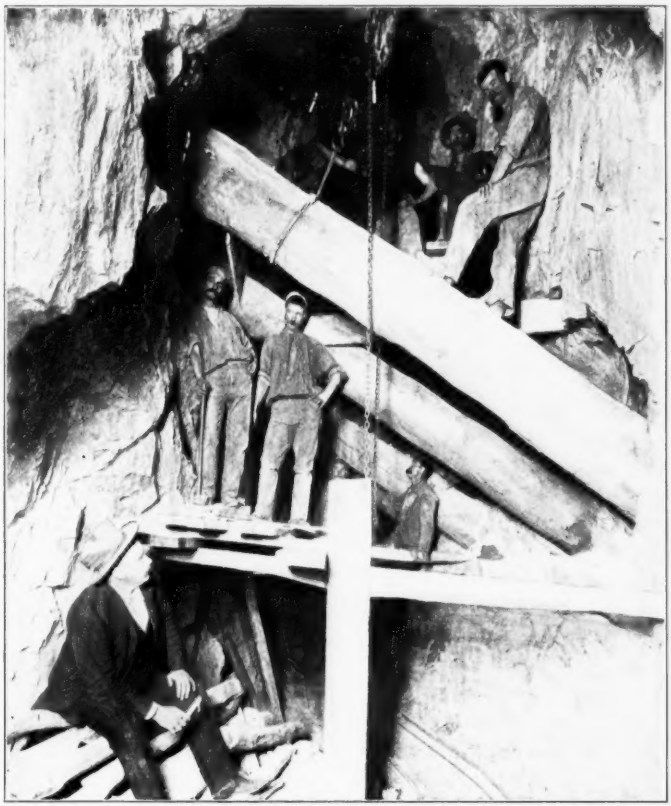


TIMBERING AND ROCK FILLING IN AN AUSTRALIAN GOLD MINE.

fumes of which, in badly ventilated parts of the workings, caused the miners to suffer from dizziness—in fact from poisoning in a mild form. To overcome this trouble the tailings are now washed with water before being sent underground; but unless washed with a cyanicide, such as sulphate of copper, which would be expensive and inconvenient, it seems open to question how far this treatment ensures safety. It is also said that in some instances the tailings contained sufficient gold to make it rather an expensive matter. Moreover, it appears doubtful, unless pack-walls or pigstyes filled with rock are used in conjunction with sands, whether the latter even when dry form by themselves a safe packing for wide stopes, although they are reported not to run as freely as one would expect them to do. The dryness of the stopes no doubt diminishes the danger of water charged with cyanide finding its way down into the lower levels, as it would in a wet mine.

If tailings can be safely employed on a large scale, this method certainly seems to achieve two useful objects: First, getting rid of surface accumulations, which are liable to block up leases of small area inconveniently; and second, obviating the expense of driving cross-cuts underground and quarrying mullock for filling, as sometimes has to be done. I may add that it appears probable that one of the directions in which mining costs will be most cheapened hereafter will be by the use of light machine drills in stoping these wide formations.

Timbering:—So long as the levels in the sulphide zone are kept narrow, they require very little timber: but when they are reached by



TIMBERING, LAKE VIEW CONSOLS MINES

the stopes from below, and the full width of the lode comes to be removed, the case is different; the caps and posts, which are of round timber, frequently run up to 15 inches in diameter, forming four-piece sets (that is to say, with a post in the middle) where the width is great.

Sometimes a line of posts is set to one side of a level, forming a man-way, with a double line of rails laid on the other and wider side; and in the Kalgoorlie mine a kind of saddle-back system of timbering is employed, consisting of stalls fixed opposite one another in hitches in the floor, butting like the rafters of a roof against a central longitudinal ridge-piece under the centre of the back of the level; the triangular spaces behind, on each side, are packed with mullock resting on lagging.* The idea is to economise timber.

For ordinary stulls and in levels which do not require massive timbering, 8-inch timber is used. The salmon-gum, which grows plentifully in the district, makes the best mine timber, it is said, becoming so hard that holes cannot be bored in it by hand.

In the stopes, posts with head-boards and cribs or pigstyes are employed to prevent caves, and the timbering and filling of the stopes is one of the main items of cost in mining in Kalgoorlie; in fact, Mr. Hoover† states it costs as much as the actual breaking and handling of the ore. The cost of timber at the Lake View Consols in 1898, for instance, amounted to £13,661.5.2, or 4s. 8d. per ton raised and treated; but of course a large part of this is chargeable to development.

Tramming:—Men are employed in trucking exclusively, but Mr. Hamilton informs me that they propose to use horse traction in the lower levels; I am not aware whether the merits of electric traction for such a purpose have been compared with it or not; but animal or mechanical haulage seems capable of profitable application only where the main levels are fairly straight, of exceptional length, and of suitable size. At the Great Boulder, the main drives are laid with steel rails, with a 17-inch-gauge track. At the smaller mines, if the roads are long, the cost of trucking is necessarily high. It might no doubt be cheapened by better organisation in some cases, 9 to 10 tons per man per shift, including stone broken in development, being reckoned, I believe, a fair day's work, which represents a cost of 1s. 1.33d. per ton shifted. This means that on a small output trucking is liable to cost 1s. 6d. or 2s. per ton of ore milled, taking into account the stone shifted for filling.

* See the *Engineering and Mining Journal*, August 18, 1900.

† *Engineering and Mining Journal*, Dec 17th, 1898.

Ventilation:—Is entirely natural, and is assisted by the difference in temperature between the surface and below ground.

Lighting:—As already mentioned, the plats are lighted by electricity, or large oil-lamps; but since the question of safety has no bearing on the matter, candles are mostly employed underground, and just as the Saxon miner in the silver-lead mines still clings to his *blende*, so the Australian, like the Cornishman, as a rule prefers his dip thrust in a lump of well-kneaded red clay, or an American steel candle-holder, which he can stick or hang anywhere. As either oil or tallow would, if dropped amongst the ore, seriously interfere with amalgamation, and might cause loss of gold out of all proportion to the saving effected by the use of a cheaper illuminant, stearine, paraffin, or composite candles are generally employed.

A GROUP OF NORTH COOLGARDIE BLACKS. NOT AVAILABLE FOR MINE LABOUR.

The cost of illumination, as might be expected, is less in stopes than in levels, reckoned on the tonnage broken; but the light being more diffused, and exposed to draughts, more candles are used per man.

Sorting:—On the Rand, Truscott points out that there is a direct saving of gold effected by sorting, in addition to a saving in reduction expenses, as the waste sorted out often does not assay 1¼ dwts., whereas the residues from reduction works generally assay more. If therefore the waste, instead of being sorted out, were crushed and treated, it would arrive at the residue dumps, with a higher assay value

than it originally had.* The capacity of the mills and reduction plants is also increased proportionately to the amount of stone thus got rid of, and the waste sorted out underground saves expense in providing mullock for packing the stopes.

In Kalgoorlie little or no sorting is attempted, and the justification for this lies in the fact that, unlike ore on the Rand, it is frequently impossible to distinguish between a piece of ore in gold and a bit of mullock. There is no doubt that the ore brought to the surface, owing to insufficiency of light underground and the dirt and smoke with which much of the ore is covered, carries a considerable proportion of waste. If this could be got rid of, it would be of distinct advantage, but what little sorting is attempted at Kalgoorlie is done merely on the dumps. To do it properly would involve the erection of elaborate washing and sorting plants on the surface, and put temptation in the sorters' way.

It is doubtful, therefore, whether the loss and cost would not greatly exceed the gain, unless the distinction between rich and poor ore becomes more marked in the lower levels of some of the mines, as may perhaps happen; in which event, surface sorting with adequate safe-guards will become a question for serious consideration.

In some mines there is, however, a good deal of barren stone, which might possibly by more careful attention to the progress of developments be separated underground, saving the expense of raising it, and leaving it where it would be most useful for filling.

Sampling:—I do not think I am wrong in stating that sampling an ordinary quartz vein, or Johannesburg banket, is child's play compared with the difficulties of sampling the Kalgoorlie formations.

When you come to consider the following facts:—(1), That ore until it is assayed is frequently indistinguishable from mullock. (2), That the ore varies in width as much as it does in value, possesses practically no well-defined walls, and is at times payable over great widths. (3), That minute seams of rich telluride are apt to run through it in all directions, bringing up the value of a foot or two of otherwise almost worthless stone to a payable grade. (4), That a given width of formation, owing to patches of rich telluride, will alter in average value from a few pennyweights to 20 or 30 ounces to the ton, in a run of level not exceeding a few feet in length—it is evident that the question of accurate sampling is a very different affair to sampling a well-defined deposit, with values as a rule fairly evenly distributed through it.

* S. T. Truscott, "The Witwatersrand Gold Fields," p. 409.

By sampling the drives at regular and close intervals, as they advance, and taking check samples from the passes and trucks delivered on surface, an approximate idea can, no doubt, be formed of the value of a block of ground, but it is practically impossible to figure with absolute certainty what any large block of ground will yield until it is actually stoped out, as it is apt to contain surprises, equally as pleasant as otherwise, in the shape of unexpected bunches of rich telluride which set the most careful calculations at defiance; and however great the sampler's experience, care, and rectitude may be, he is liable to make unavoidable mistakes in estimates of the kind based on ore in sight, using the term as ordinarily understood.

The foregoing facts may possibly in some measure explain the startling discrepancies that have occurred in estimating ore in sight. A most notable case was one in which, according to the chairman of the company, the late manager calculated the reserves of one of the principal mines in August, 1899, at 739,296 tons, valued at 1 ounce 16 pennyweights, whilst mining engineers who inspected the property in April, 1900, reported only 37,740 tons, valued approximately at 1 ounce 8.33 pennyweights. The difference in this instance is quite incomprehensible.

Developments Underground:—Sufficient has been said, however, to show that in order to maintain a large output, with a regular mill-average, whilst adding gradually to reserves, it is even more necessary in some mines than in others to keep development work pushed well ahead at different levels. The following tables, compiled from official reports, giving the records of four of the mines of the field in 1899, illustrate this:

Scale of Treatment. Tons.		Authority.	Year.	Est. Ore Reserves, Dec. 31st, 1899. Tons.	Sunk. Feet.*	Driven. Feet.	Cross-cut. Feet.	Total Feet.
59,664	Ivanhoe	Co.'s Rep.	1899	Oxidised, 128,273 Sulphide, 83,600 Total, 211,873	1,436	3,371	1,542	6,349
85,889	Lake View	do.	1899	Sulphide, 304,800†	1,235	3,221		4,456
72,865	Gt. Boulder	do.	1899	Oxidised, 17,266 Sulphide, 131,878 Total, 149,144	2,579	5,195	1,750	9,524
11,534	N. Boulder	do.	1899	Sulphide, 5,000	1,222	1,488	1,419	4,129

If rises and winzes are included, the general average cost of de-

* Shafts, winzes, and rises.

† Exclusive of oxidised ore, of which no estimate is given, but reported to be a large amount.

velopment, according to Mr. Hoover, has been about 4s. 6d. ($1.08) per ton of ore developed. As he adds, however, "this figure must be taken with a grain of salt," the cost being liable to be largely increased by the necessary prospecting work in cross-cutting, etc., looking for new ore-bodies. Were it not for this, the development of a given tonnage of ore would be quite a cheap item, and the drivage on the actual ore-bodies could be kept at a comparatively small figure, without fear of reserves falling suddenly short.

Mr. H. C. Hoover* states that one of the most difficult problems in the West Australian mines is the inefficiency of the labour (wages representing, he reckons, about 80 per cent.† of the cost of sinking and driving). It is true, he adds, this is improving with time, but even now the amount of work accomplished per man per day is astoundingly small. In one mine the men stoped quartz, in a body 20 feet wide, at the rate of 1.8 tons per man per diem. In another mine, in soft lode matter under best conditions, 2.7 tons per man per diem. It may be added that each foot of thickness of ore (reckoning it at 12 to 14 cubic feet to the ton in place) may be estimated to yield 2½ to 3 tons per square fathom (6 by 6) stoped.

Surface Haulage:—Several of the mines at Kalgoorlie are connected by siding with the Government steam tram-line, but drays and horse teams are still extensively used, and overhead tramways on trestle work, operated by manual labour, are laid to the mullock dumps.

At Lake View, the ore broken in the stone-breaker is raised from storage bins at the main shaft by an endless wire-rope way to the top of the mill; at the Lake View South, the mill which stands on a hill is connected with the main shaft in an ingenious way, by a tramway laid on trestles, set at such a grade that the trucks landed on the top landing-stage of the head gear will run by gravity down to the mill rock-breaker floor, and can be returned on a reverse grade to a lower platform on the poppet legs, which are built specially high to allow of this being done.

The larger mines do their own repairs, and are provided with lathes, punching, shearing, slotting and drilling machines, and woodworking machinery, and the Great Boulder have erected a small iron-foundry of their own.

The next article of this series will deal with milling and cyanide practice at Kalgoorlie.

* "Mineral Industry," Vol. VI., p. 335.

† I think, as shown by the foregoing data, it is really higher.

TURBINE BUILDING AND TURBO-ELECTRIC STATIONS IN SWITZERLAND.

By Franz Prášil, Professor at the Federal Polytechnic Institute in Zürich.

One of the greatest services electricity has rendered—possibly in the end it will prove the greatest—is that it has made possible the use of long-neglected stores of force. Economy is the great principle of modern material effort—economy in the conservation as well as in the utilisation of the natural resources of the earth. Nowhere, perhaps, is there larger opportunity for its exercise than in making serviceable the world's many water powers. To meet the wide range of conditions they present and enlarge the radius of their usefulness, has required some of the closest study and cleverest work of the hydraulic engineer, the mechanical engineer, and the electrician. Switzerland is pre-eminent in advance in electro-hydraulic practice. By this alone it has held a high position in industrial development in spite of its lack of coal. Professor Prášil is one of the leaders in this branch of engineering, and his review of the progress attained is thus invested with especial value.—THE EDITORS.

ATURE has not endowed the Swiss soil with those treasures that in other lands form the basis on which private and public wealth is built, through industry and trade, and yet Switzerland is a leading industrial country, able, with its products, successfully to maintain its position in the commercial world.

This is made possible because its many water powers atone so plenteously for the lack of coal that very often the saving in power cost is great enough to pay for the transportation of products to the borders of the country, and even as far as the great world-markets, and also because the people, owing to the thorough training in their technical institutions, and their intense practical activity at home and abroad, possess in an eminent degree the capacity for the production of goods of high quality. Machine building takes a leading position among Swiss industries, as is evidenced by the success achieved at the Paris Exposition. In particular, the manufacture of turbines has developed to such a degree, in consequence of the need for making the most of the country's water power, that it is now carried on by twelve companies, whose machines are sold all over the world.

Among these twelve companies, the five following have made turbine building the main branch of their business and devote special sections of their shops and offices to it: Escher Wyss & Co., Zürich; J.

J. Rieter & Co., Winterthur; Theodor Bell & Co., Kriens, near Luzern; Ateliers de Constructions Mécaniques de Vevey, and Piccard, Pictet & Co., Geneva. Among other companies which also manufacture turbines are: The Basel Maschinenbau-Actiengesellschaft; Benninger & Co., Uzwil; M. Bosshard, Zürich, etc.

The diagram, Figure 1, gives a view of the total production of the first five companies, in number and capacity of machines, per year.

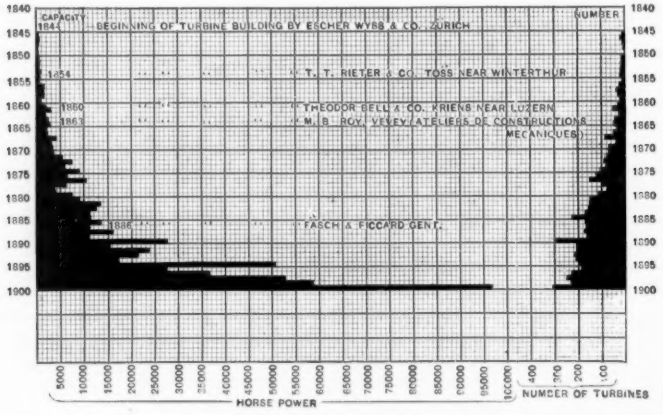

CAPACITY
NUMBER
1844 BEGINNING OF TURBINE BUILDING BY ESCHER WYSS & CO. ZÜRICH
1854 J. J. RIETER & CO. TÖSS NEAR WINTERTHUR
1860 THEODOR BELL & CO. KRIENS NEAR LUZERN
1863 M. B. ROY, VEVEY (ATELIERS DE CONSTRUCTIONS MECANIQUES)
1886 FASCH & PICCARD GENF
1840 1845 1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900
5000 10000 15000 20000 25000 30000 35000 40000 45000 50000 55000 60000 65000 70000 75000 80000 85000 90000 95000 100000
400 500 600 700 800
HORSE POWER
NUMBER OF TURBINES

FIG. 1. GRAPHIC REPRESENTATION OF THE ANNUAL OUTPUT OF TURBINES BY THE MOST IMPORTANT SWISS BUILDERS.

I shall have occasion later to return to this, summary statement; at this time I need only remark that the total production of these five companies from 1844 to the end of 1899 was, in round numbers, 5,850 machines, with a total capacity of 638,000 horse power, that the output for 1900 exceeds that for 1899, and that in consequence of the prominence of these companies, their production well illustrates the condition of the manufacture of turbines in Switzerland.

The development of the individual companies and the arrangements of their works cannot here be gone into in detail, but a brief account must suffice.

The firm of Escher Wyss & Co., besides its main establishment in Zürich, has a branch in Ravensburg, Würtemberg, where turbines are also built. In 1894 and 1895 the main works were moved from their old site, opposite the principal railway station in Zürich, to a new location in the so-called Hard, where the manufacture is carried on with the most modern shop appliances.

The *Schweizerische Bauzeitung* for 1895, volume XXVI., page 72 and following, gives a complete, illustrated description of this establishment and its hydro-electric station in Zufikon-Bremgarten. The latter will be spoken of later on in this article, and to this short account of the works proper is added an illustration, Figure 2, which shows the turbine-erecting room in the 110-metre by 100-metre (360 by 330 feet) main shop. It may also be mentioned that Escher Wyss & Co., besides building turbines, make steam engines, boilers, complete outfits for paper factories, refrigerating plants, etc., and also construct aluminum boats and do other ship-building work.

The firm of J. J. Rieter & Co., in close connection with the manufacture of spinning-mill machinery, has engaged extensively in turbine building at its shops in Töss, near Winterthur, which are illustrated on page 55 of the book issued by the Schweizerische Ingenieur und Architekten Verein on the occasion of the thirty-eighth annual meeting in September, 1899. At those works the firm has its own hydraulic-power station, which gives it a field, even though a somewhat narrow one, for testing its turbines.

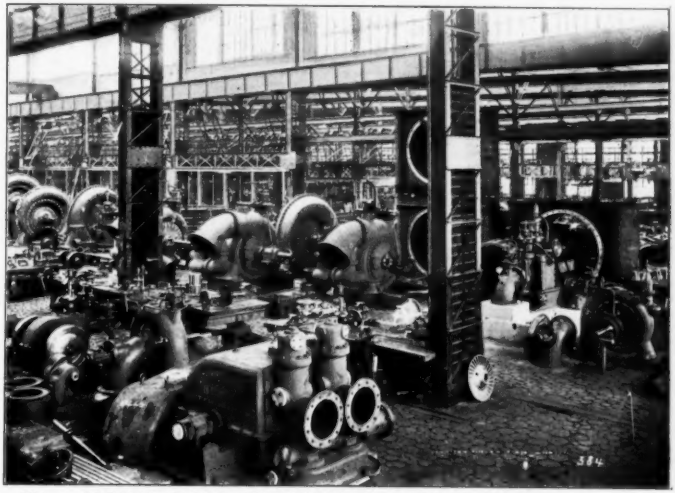


FIG. 2. ERECTING ROOM OF THE TURBINE DEPARTMENT, ESCHER WYSS & CO., ZÜRICH.

The firm of Theodor Bell, at Kriens, near Luzern, which, besides building turbines, does a large business in structural iron, has also modernised its manufacturing methods since its works have been connected with the hydro-electric station which it erected at Rathausen,

near Luzern. Figure 3 shows part of the erecting room, with one of the large 1,350-horse-power turbines for the Hagnek Electric Works, on the Lake of Biel, in course of erection.

The machine works founded by M. B. Ray and now bearing the title of Ateliers de Constructions Mécaniques de Vevey, were newly fitted out in 1894 and 1895. The firm of Piccard, Pictet & Co., of Geneva, formerly Faich & Piccard, after carrying on operations for a short time in a small shop, has, within the past year, also moved into a new, entirely modern establishment in "les Charmilles," near Geneva.

The works which have been enumerated, and which employ from 2,500 to 3,000 men in the manufacture of turbines alone, are thus shown to be well-equipped, so that, with their thoroughly trained personnel, they are fully able to meet any demands which may be made upon them.

The qualitative progress can be best studied in the works that have been carried out, in which is evidenced the mental labour of the designing and constructing engineers, as well as the ability of the shops.

It would no longer be of interest to consider the many older plants which, in the course of a comparatively long development, were built for the greatest variety of purposes, as well as for various heads and quantities of water, and in which the water wheels were mechanically coupled to the driving machinery of the factories. Even the power stations with wire-rope transmission at Schaffhausen, Bellegarde, and other places, which, on account of their daring engineering work, were epoch-making, are now of historical interest only.

Moreover, these older plants have been fully treated of in engineering literature, and attention is called to the well-known book, "The Theory and Construction of Turbines and Water-Wheels," by G. Meissner, engineer, published by Costenoble, of Jena, which in its first edition had a rich collection of plans and detail drawings of prominent works.

With the rapid rise of electrical engineering came a higher consideration for water-powers. Figure 1 shows very clearly how, in the second half of the eighties, the production of turbines began to make a striking, though somewhat spasmodic, advance. This was the period in which the first large hydro-electric stations were designed and built, thereby making vital a series of problems whose solution demanded the best efforts of the engineers. Among these problems were the construction of exactly-working automatic governors and an increase in the number of revolutions with even small heads, so that wheels could be directly coupled to generators.

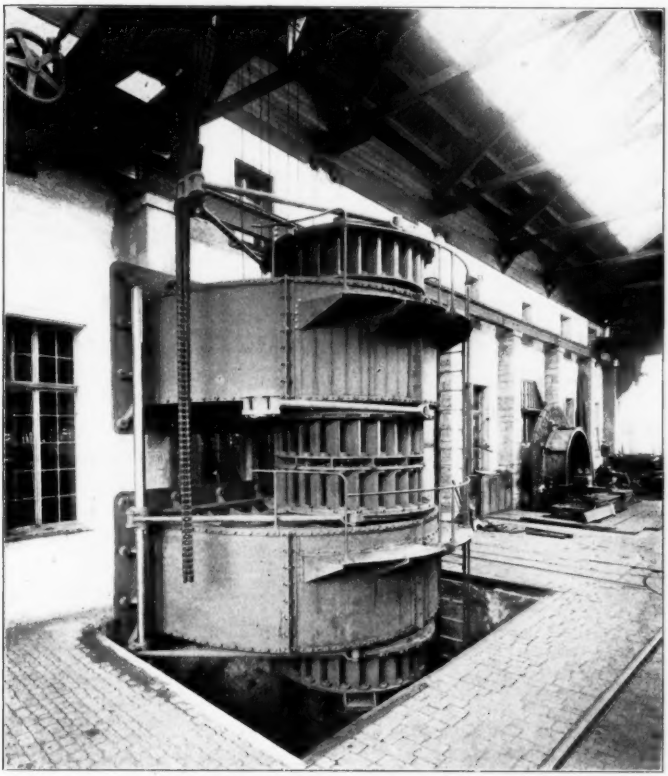


FIG. 3. A 1350-HORSE-POWER TURBINE, DESIGNED FOR THE ELECTRICAL WORKS AT HAGNEK, AS IT APPEARS MOUNTED IN THE SHOPS OF THE THEODOR BELL COMPANY, KRIENS.

It therefore appears proper to follow the progress in turbine construction from this time on, and the year 1889 may be taken as a starting point, for then the first hydro-electric stations with a number of similar units were either contracted for or built.

The large water-works of Coulouvrienniére at Geneva, and Letten at Zürich, which were built primarily to supply these cities with water, and in which there were also a good many similarly constructed turbines, were already in operation at this time. These works, it is true, showed a considerable advance in hydraulic engineering, and were of influence on turbine building in so far as they showed the great adaptability of concrete for the construction of turbine chambers of

unusually large size. The construction of the turbines themselves, however, shows nothing essentially new, with the exception, perhaps, of the great dimensions of the Geneva wheels. As is well-known, the latter are multiple-ring reaction turbines, with hand regulation, built by Escher Wyss & Co.*

The first large hydro-electric stations, which were built in 1889, were the Schaffhausen central station and the power station of the Neuhausen Aluminum Company.

The Schaffhausen station, which was begun in 1887 as an addition to the power plant of the historic wire-rope transmission, displayed no novelties so far as the arrangement and the construction of the turbines were concerned. Two-ring reaction turbines, some of them built by J. J. Rieter and some by Escher Wyss & Co., drive the horizontal shafts of the generators through bevel gearing. Each turbine is constructed for a capacity of 300 horse power with 4½-metres (15-foot) head.†

The turbines of the Aluminum Company, built by Escher Wyss, which are directly connected to dynamos, have a novel feature designed to lessen the pressure on the bearings of the vertical shaft.

These otherwise normally constructed reaction turbines, each having a capacity of 600 horse power with 20-metres (66-feet) head, are so arranged in their casings that the water flows through them from below upward, and thus causes an upward pressure in the direction of the axis which counterbalances the downward pressure due to the weight of the various parts. Besides this, as the energy required varies rapidly, there is a quick-acting throttle-valve in the siphon-shaped delivery pipe, which satisfies the requirement for prompt regulation.

In 1890, the hydro-electric station at Berne was built.

On account of the considerable variations in head—from 3.5 to 1.85 metres (11.5 to 6 feet)—the three 150-horse-power reaction turbines, from Bell and Co.'s Kriens works, are constructed with three rings, the middle ring having an automatic governor and the other two being regulated by hand. The wheels rest on concrete founda-

* The reader is referred to a work entitled "Utilisation des forces motrices du Rhone," published under the direction of the administrative council of Geneva, 1890; Librairie Georg, Geneva.

† An address on this plant, delivered by Dr. Alfred Amsler at the meeting of the Institution of Electrical Engineers in the hall of the Zürich Polytechnikum, on the occasion of the visit of the Institution to Switzerland, is published in the Journal of the Proceedings for 1900, part 143, volume XXIX

tions, in which the channels for the discharged water are cut in a special patented way.

In 1891 was begun the installation of the Zürich electric station at Letten, the hydraulic plant of which is remarkable in several respects: The dynamos can be driven by two sets of turbines. One set is fed by the main reservoir of the water-works, while the second set, consisting of high-pressure turbines, obtains its water from an auxiliary reservoir, which is filled by pumps at the water-works whenever there is a surplus of power. The 300-horse-power high-pressure turbines, built by Escher Wyss & Co., have spoon-shaped buckets and are provided with hydraulic governors. We have here, then, a hydraulic accumulator plant, which enables the water power of the Limmat to be scientifically utilised.

This construction of turbines and governors was not, it is true, first made in 1891, but this plant gave an opportunity for a series of experiments in regulation which were of importance for the development of such arrangements of water-wheels.

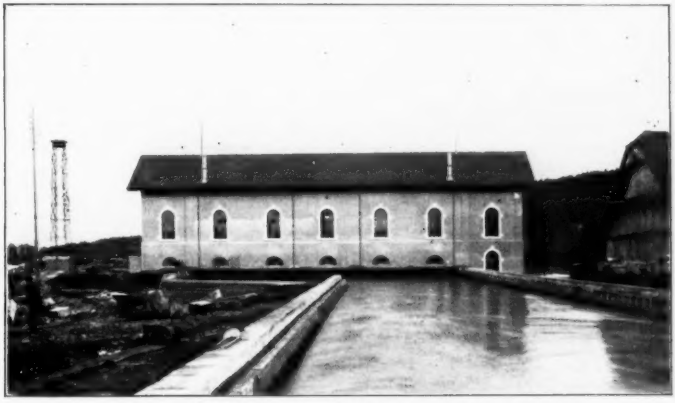


FIG. 4. RATHAUSEN ELECTRICAL STATION NEAR LUZERN.

The epoch-making results of the power transmission from Lauffen to Frankfort-on-the-Main had the effect in Switzerland, as well as in other countries, of setting free long-latent ideas concerning the utilisation of water-powers on a large scale. Besides the projects already conceived there arose new ones, and so we find that in the years 1892 to 1896 a number of great works were undertaken, each one of which shewed an advance in hydraulic construction.

Beginning with the installations on the Aar, we find that the plant in Interlaken has three units of 180 horse power apiece; Thun has

two units, each of 120 horse power, and Olten-Aarburg has six 300-horse-power units. The hydraulic machinery for all of these was furnished by Bell, of Kriens.

The turbines of the first plant are double-ring reaction turbines, with patent aspirators, and are quite similar to those of the Bremen plant: the Schaad automatic governor was used for the first time with them. The construction and operation of this governor were described by me in my report on turbines and their governors at the Geneva Exposition in 1896, published by Ed. Rasher, Zürich.

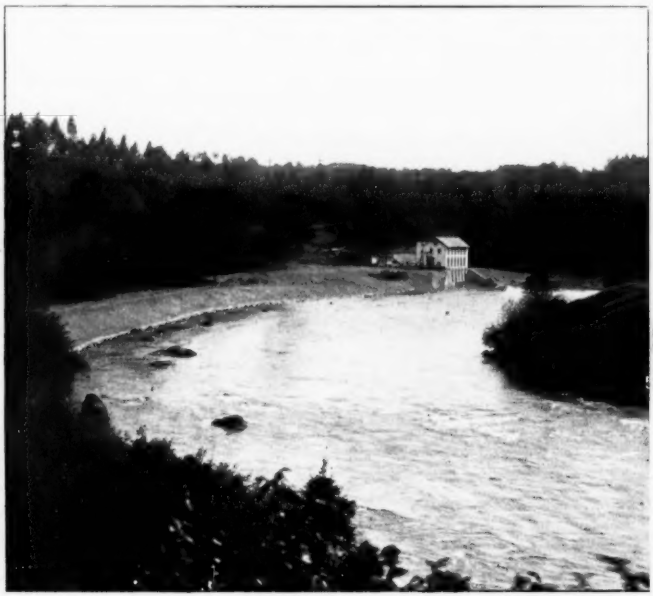


FIG. 5. TURBINE STATION, ZUFIKON-BREMGARTEN ELECTRICAL WORKS.

The turbines in Olten-Aarburg are three-ring reaction turbines of very large dimensions, and are characterised by a very thorough equalisation of the blade-angles in each ring. The employment of a forged shaft, hollow throughout, may also be mentioned.

In these three installations we find already a striving towards, and also progress in the attainment of, the most exact regulation possible, as the use of the above-named governors has led to thoroughly satisfactory results. But it is undeniable that there was found no adequate solution of the difficulties encountered if high speeds were to be used,

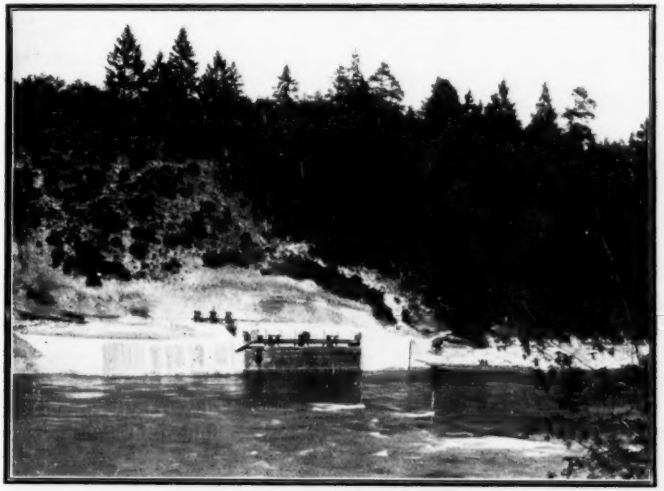


FIG. 6. ENTRANCE TO HEAD RACE TUNNEL, ZUFIKON BREMGARTEN WORKS.

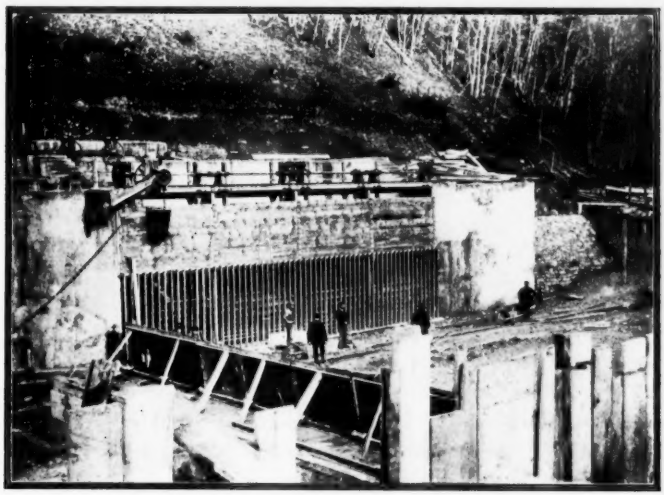


FIG. 7. SLUICE GATE AT ENTRANCE TO HEAD-RACE TUNNEL, ZUFIKON-BREMGARTEN ELECTRO-HYDRAULIC INSTALLATION.

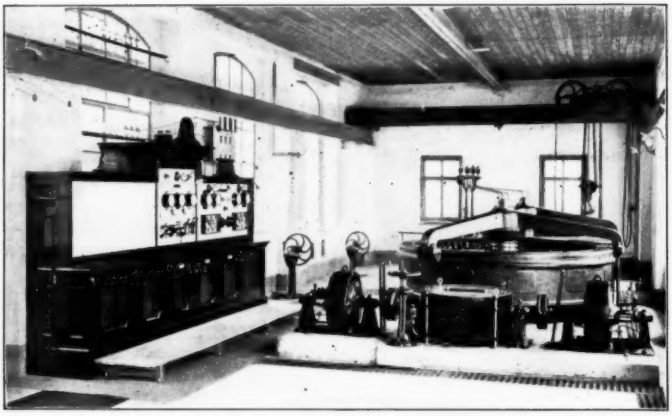


FIG. 8. ZUFIKON-BREMGARTEN WORKS. MACHINERY ROOM.

although this would have been desirable on account of the comparatively small and very variable heads which are characteristic of the conditions at all three plants.

Other installations on the Aar are those of the Wynau electric station, with five 750-horse-power units and two 120-horse-power units; of the town of Aarau, with two 400-horse-power units and one 200-horse-power unit, and of the town of Brugg, with two 150-horse-power units. All these turbines, with their attachments, were supplied by J. J. Rieter & Co., of Winterthur.

During the period from 1892 to 1896, the electric stations at Rathausen, near Luzern, and in Zufikon-Bremgarten were erected on the Reuss.

The hydraulic machinery of the Rathausen installation is a culmination of the type of low-pressure plant that has hitherto been manufactured by the Bell Company; a careful working out of all the mechanical details, as well as a convenient and easily accessible arrangement of all the parts make this plant a model one.

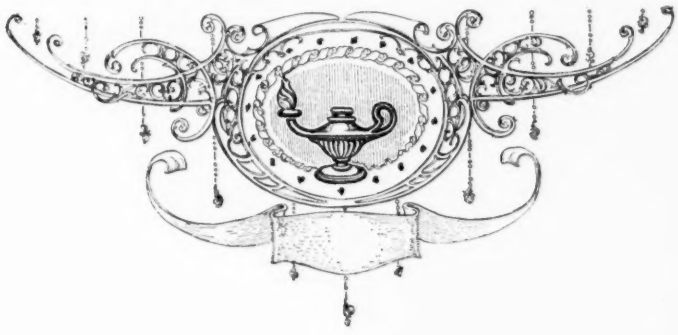
With a head varying from 4.12 to 4.82 metres (13.5 to 15.8 feet), this station has a capacity of from 1,200 to 1,500 horse power, which is converted into electric energy by means of direct-coupled two-phase generators with a voltage of 3,300, and thus supplies Luzern and the vicinity with power and light. Figure 4 on page 251 gives an outside view of the station.

The plant in Zufikon-Bremgarten, already mentioned, is of high

interest because it shows a decisive attempt to increase the number of revolutions.

The plant is shown in Figures 5 to 8; it is near the little town of Bremgarten, in the Canton of Aargau, where the Reuss makes a bend of nearly 180 degrees. By building a dam 70 metres (230 feet) long at this point, a head of from 5 to 6.5 metres (16.4 to 21.3 feet), gross, was secured, and the water is led through a tunnel 350 metres (1,150 feet) long, the maximum flow being 25 cubic metres (883 cubic feet) per second, directly to the turbine house.

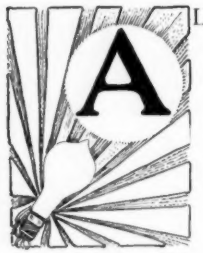
In order to secure a higher speed, the turbines, built by Escher Wyss & Co., are double ones in concrete casings. There are four units, each of 325 horse power at 115 revolutions per minute, and each directly coupled to a 5,000-volt polyphase generator. Of the available energy, 400 horse power is transmitted to the works of Escher Wyss & Co. and 200 horse power to the flour mill of Messrs. Maggi & Co., a distance of 20 kilometres (12.4 miles), by means of two three-wire lines. The remaining energy is delivered elsewhere. Work is in progress for the purpose of getting an increased head of water, and in connection therewith new forms of turbines will be used. The completion of the original part of this plant occurred at the same time with the closing of contracts for the installation of the two largest hydro-electric stations of the Continent, those of Chèvres, near Geneva, and of Rheinfelden To the description of these important stations my second and concluding paper will be devoted.



THE UNKNOWN MINERAL DEPOSITS OF THE PHILIPPINES.

By Frank L. Strong.

The truest service which can be rendered to industry and capital is sometimes to warn them against over-assurance. To know that the received information on a subject is misinformation—to know that there is no exact information—is the beginning of real knowledge. It is in this spirit that Mr. Strong writes, with the preliminary explanation that the review of the mineral resources of the Philippines at this time can scarcely be more than "a large I don't know."—THE EDITORS.



ALASKA possibly excepted, no transfer on a large scale has ever been made in modern times of land about which so little is known by either the old or the new owner as in the case of the Philippine Islands.

Spain, indeed, left many records, geological, climatical, agricultural, mining, etc., many of which were made with the appearance of elaborate painstaking as to facts. But Spanish policy frowned upon manufacturing, and no incentive was offered to develop what the records said existed.

These records present many a rosy picture to the new arrival. Clear, explicit, frequently accompanied by elaborate drawings, he feels he has but to follow to success a track made clear by his predecessors. A few months, and the illusion is dispelled; he has learned to distrust all information derived from Spanish sources.

It is not asserted that these records were made to deceive. Not at all. Terse, clear-cut statements of fact, arrived at after painstaking, scientific research, are a modern innovation upon the easy-going guesses and traditions of the past. But few nations have reached the point even yet, Spain being one of the laggards.

To illustrate the Spaniard's lack of accuracy may be cited the case of the Manila & Dagupan railroad, some 120 miles long, the only railroad on the Islands. The Spanish Government had the line surveyed by its own engineers. Elaborate charts were prepared, showing all details—route, grades, fillings, borings for bridge foundations, etc. English capital became interested, a rigid contract was entered into, and the work was begun. It was discovered in many cases that the engi-

neers reporting the survey had never been upon the ground—that the road as laid out was impracticable. Marshes and quicksands were found where the drawings indicated solid ground, and dense jungles existed on the route where the foot of man had never trod. Even rivers were there of whose existence the engineers were ignorant.

The English company was obliged to expend largely in excess of the estimated amount, and had to face many grave engineering problems the Spanish engineers had not dreamed of while surveying the route from their comfortable office in Manila.

To attempt in a brief paper to speak even in general of all the resources of the Philippines would be futile. Unexplored as they are, as a whole, by competent observers, the Islands from all that can be gathered are extremely fertile in soil and rich in timber, minerals, and all else requisite for great manufacturing industries. Easily controlled water power is found in numerous places. In this paper I will briefly touch on mining features only.

Gold naturally is of primary popular interest. During the year of the Spanish-American war I met many members of the Colorado Volunteers, who came here intending to remain after their terms of service expired, and search for gold. They were expert miners and many did remain. Hundreds of others have come from the States and elsewhere on the same errand. While the insurrection greatly limits their field of search, our local newspapers teem with their wonderful discoveries. I meet many personally, am shown small vials of virgin ore, specimens of quartz of great richness, and hear the old, old stories so familiar in the States. From the friars, who have lived for years in the interior; from old residents, who know it all; from Spanish Government records and other sources—I am surfeited with gold talk.

Possibly I am over conservative, but I have seen and heard of nothing yet to make my pulse beat one stroke faster. Gold can easily be obtained from the natives. One of the mines most famous in past years is found to yield an industrious native about five cents' worth a day. As he cannot eat or smoke it, it accumulates on his hands, until by several months' labor he gets an amount which will fill a tiny bottle half full. This is the gold my prospecting friend buys and exhibits as his "find." There are many such celebrated mines in Spanish records.

In dismissing this subject I do not say gold may not be found here in paying quantities. Much is found in Japan, where geological conditions are probably similar to those here. The insurrection prevents extended search. Spanish lethargy may have passed unnoticed what to an American would prove a bonanza. The new processes of the day

may utilize ore which is beyond the reach of the crude methods of the native. All one can say to-day is that we know practically no more than before the United States took the islands.

Land titles are yet to be decided, and the numberless claims now being staked out may not be worth the value of the stakes to the man who drives them, even if the metal is found in the future. A miner's exchange has recently been organized in Manila, commencing with one hundred and twenty *bona fide* miners of those directly interested. This will tend to place matters in a business form, and the mining legislation expected in the near future will establish a basis to work on.

The world will doubtless soon know if the Spaniard, whose scent for gold in past centuries was keener than that of any other nation, has slumbered for three hundred years on his own El Dorado. If its undiscovered richness has fallen into the hands of his conquerors, this would indeed add to his overflowing cup of bitterness.

Coal:—To the prospective investor a subject far more important than gold is presented. Coal is king. For the scores of steamships of the present, and the hundreds of the future; for the railroads projected and certain to be built; for the coming manufacturing industries—coal is imperative.

I have gathered statistics from many sources—Spanish records, both public and private have been at my disposal—and I am in close touch with those owning mines, whether opened or prospective.

There have never been found in these islands to date anything but lignites. Of these, large deposits exist, widely distributed among the various islands. Some are easily accessible to the sea. One of the largest and most important worked would require an expenditure of $100,000 to put in a railroad and other essentials for handling the product. About fifteen tons per day is its present output.

Philippine coal much resembles that of Japan, none being equal to that of Australia, so largely sold here.

That I have thus far examined includes samples from some of the best-known mines, giving an analysis about the same as that of the average Japanese coal. However, as Japan contains one mine so superior to others that the government there controls its entire output for naval vessels, so we here may at any time find grades of superior excellence. I had strong hopes of being able to analyze samples from a mine located near the coast of southern Luzon. It is said all small Spanish gunboats that could enter the port formerly coaled there, and its quality was above the average. You will understand difficulties of obtaining reliable data at first hand from the fact that a friend inter-

ested in the mine, who was to send me samples for analysis, was murdered by natives while examining the property. His two white companions were also boloed.

As Australian coal sells in this market at $10 a ton gold, and not a strong coal at that, and Japanese coal at $9, the incentive to open up mines is very great, and we shall look for much activity in that line as soon as the insurrection closes.

Copper:—The islands have large deposits of very rich copper ore. Before the insurrection the local market was wholly supplied from mines to the northward of Manila. I know of great quantities of ore, at present too far from the market to admit of mining at a profit. Facilities which will be provided later will put it on board cars. Smaller but very rich mines can be worked to good advantage now.

Iron:—The iron ore of the islands is said by reliable authorities to be of superior quality. Futile attempts to mine and prepare it for the market have been made in recent years, but impediments thrown in the way by the Spanish authorities resulted in their abandonment. These deposits are said to be very large, are easily accessible, and with the known excellence of quality are simply awaiting the time when conditions warrant the necessary expenditure of capital to utilize them.

Other Ores:—Manila contains two excellent museums, in which are exhibited all articles of interest from the islands. In these are seen samples of almost every known ore. That large deposits exist of all the useful ores, is the evidence of all whom I have met, whose long residence and facilities for observation entitle their opinion to weight.

The knowledge of the resources of these islands I obtained while an engineer in the Navy during the Spanish-American war has been greatly increased. The facts upon my first visit, obtained from some thousands of miles cruising among the islands, and from interviews with those in position to know, led me to return. My added knowledge has decided me to remain after my duties as consulting engineer for the construction of the half-million-dollar refrigerating and ice-making plant shall have ceased.

Too much stress cannot be laid upon the wisdom of American manufacturers of machinery securing an early representation in this field. The machinery selected for the government plant just mentioned, and many thousands of dollars' worth placed elsewhere, have proved a revelation to users here. English machinery has had entire control, but American manufacturers have but to bestir themselves and adopt the same methods of selling as the English, to secure the trade.

THE STEAM MOTOR TRUCK AS A PORTABLE POWER HOUSE.

By James Grieve Dudley.

The motor truck seems destined in the very near future to affect materially the economy of the distribution of goods. Its more immediate interest to a mechanical constituency, however, is its rapidly rising importance as the basis of a new mechanical industry of production. Hence the importance of all study or discussion tending to fix the principles or standardise the practice of its construction.—THE EDITORS.

EMANDS for motor vehicles have now assumed such proportions and permanence that the engineering world is fully warranted in asking whether we may not evolve from all this agitation over what is now the rich man's plaything —the modern machine for racing or pleasure— a motor truck which may successfully supersede horse traction of heavy loads, on a basis both sound commercially and practicable mechanically. Such an achievement would open up, I think, additional fields for its adoption, since success under unfavorable road conditions would render doubly possible its success under the fixed and favorable conditions of rails, at least.

So broad is the subject that this discussion will be confined to an analysis of the fittest substitute for the hauling of heavy loads by known and tried motive powers at the present day over city streets and country roads, as they are now to be found in the United States only.

The fittest motor truck must, first of all, meet every requirement of existing horse-drawn trucks; second, its initial cost must be within the means of the buyer; third, its operative cost must represent a better investment than the care and keep of the horse. The second condition can be demonstrated only in the open market, but the third assumption I shall assume to be admitted as possible, certainly when, for instance, a design shall be evolved which shall fulfill the specifications laid down herein.

Elimination of horse traction, or rather the substitution of mechanical propulsion, instantly sets us certain definite limitations and gives us a wholly new point of view of the hauling of goods, as for instance in the adding to the truck itself of the weight of the motor parts with their accessories, in order to *drive* such loads as were formerly *hauled*.

Every pound thus added to that of the existing truck should be so applied as to bring the centre of gravity of the whole as low as possible, and further should be so distributed that the tractive force on the face of the drivers should be in proportion to the live load carried. Under no conditions should the dead load be less than that of the horse displaced; a position which disposes of the revival of the early though fallacious attempts to solve the problem with so called "tractors."

A comparative analysis of the fittest known and tried motive powers for this given service is beyond the scope of this inquiry, and will not be here attempted; yet in support of the premises hereafter assumed it is necessary at least to predicate the standards and limiting conditions under which such an analysis has been conducted and my resultant conclusions have been reached.

Primarily then, our hypothetical motor must possess that *sina qua non* of every machine which is to be handled by persons not only untrained but often grossly ignorant, namely, safety.

To meet the requirements of the average American our machine must be well-nigh automatic in its simplicity of operation, for a nation of indefatigable inventors are satisfied with little which calls for that skill and attention in the handling of machinery which others are able and willing to spend in reaching given results.

Durability should, for like reasons, stand well to the fore if the motor truck is ever widely to supplant or largely to supplement horse traction.

To compete successfully with the horse, the motor truck must possess that same reliability upon which, for example, the farmer depends in daily delivering his horse-drawn load of produce to the city markets.

Since we can set no limitations to the character of locality or goods-service which shall determine the adoption of horseless trucks, it follows that the fittest must be absolutely independent of any fixed base of supplies, or repairs, or source of operative skill; for, if successful upon the sandy roads of Florida, it will be wanted, and should be equally successful, upon the rocky roads of the mountains of the far northwest. As a matter of fact it is a fair presumption that the evolution of a motor truck fittest for the severely adverse American conditions is likely to develop a type which will recommend itself for well-nigh universal adoption.

The ever varying conditions of the weight and character of loads hauled, of roads, of grades and weather, call for unusual flexibility in the delivery and manipulation of the selected power, whatever that may be.

Economy of operation must be the final determining factor as to which motive power is most fit, but not until the competitors for this honor have tied on all other scores.

Comparing then, the known and tried motive powers with these standards—safety, simplicity, durability, reliability, independence, flexibility, and economy of operation—it appears that, as the fittest for the motor truck which shall have wide adoption, steam should be the motive power selected. Assuming steam to be adopted for our proposed truck, there naturally arise most of the questions discussed and many of those disputed in the engineering world every day in stationary, locomotive, and marine practice. It is well, I think, to start out with the axiom that "What is wrong on fixed foundations is doubly wrong on moving ones." Yet on the other hand, it hardly follows that "The best in stationary practice is necessarily the fittest for motor-vehicle work." Where, however, it is commercially feasible and mechanically and practically possible to employ the refinements of advanced engineering, then the corollary of our axiom certainly should be carried out in our designs.

With these axioms, corollaries, definitions, and conditions before us, let us see what we may fairly demand in our specifications for a steam motor truck, which shall most nearly meet the stipulated desiderata. Starting with the necessary fuel, it should be: ashless, smokeless, condensed, of high calorific value, absolutely safe, cheap, and universally obtainable. Kerosene and fuel oil alone meet these conditions.

The burner therefore should be noiseless, non-clogging, non-carbonizing, automatic, safe, and simple. A search of the market or the patent office will disclose multifarious means devised to accomplish these results, though the process of evolution does not seem to have yet brought forth the fittest.

We next advance to the boiler. Could we settle this point for motor-vehicle service, we would unquestionably settle it for well-nigh every service; hence I shall simply lay down certain dicta and stand on guard to meet attack. The given service is such that one prime requisite of all boilers must here take precedence of everything else, namely, absolute safety. But one type of boiler wholly meets this condition, if we may except the so-called flash boiler, and that type is the water-tube. For motor-vehicle work, there must be added one other desideratum at least, namely, that it shall be self-contained. Intimately associated with boiler design arises a point too often disregarded, certainly in stationary practice, and that is securing the maxi-

mum of heat insulation; for, why seek high furnace temperatures, rapid steaming, superheated steam and feed-water, if radiation (intensified by the very character of the work to be performed) goes on unchecked or poorly prevented? A problem by no means easy of solution is that of the boiler feeding, since, in the whole field of steam engineering, we can scarce find a parallel to the fluctuations of grade, steam-demand, load, etc. The natural attempt at a solution of this problem is to employ the pump in some form or other, but it requires no great expenditure of thought to conceive situations where means more automatic and flexible must ultimately be devised if we are to master the steam-motor-truck problem. As a *sina qua non* in our portable power house, there should be a feed-water heater of high efficiency, the particular form of which may be made to suit the fancy of the individual designer or the special needs of the truck in hand, so long as the maximum results are attained in pre-heating the boiler supply. There are many points of similarity in the functions of boiler and heater, hence many of the essentials in the construction of the former have equal weight in devising the latter.

The *crux* of the whole steam-motor-vehicle question might be summed up in water purification. Under no other service is the steam boiler subjected to conditions so severe as when compelled to "travel upon its belly through an enemy's country." It is evident that I am assuming here, as I have above and shall below, that we "in the States" are hardly yet ready to "run condensing." Since we throw away our exhaust, we must subsist on anything and everything obtainable in a liquid form which passes under the name of water. There are, of course, many solutions of the problem of purification, but none can be made to cover all cases; hence we must carefully investigate each and every one and adopt such means and methods as are best suited to the individual conditions. One method we must not even take into consideration, and that is the use of boiler compounds. Every steam-motor-truck designer should raise his voice against even initiating this practice, and thus safeguard an art of fast growing responsibility and proportion. First of all, boilers of whatever size, type or design should be so constructed as to make every possible provision against the harmful effects of bad water, if used, and, by insuring continuous, rapid, and free circulation, prevent the lodgment at any time of impurities at any point in the system, save in some entrapping drum specifically provided therefor. Next, if possible, boilers should be fed only water which is known to be free from organic or inorganic matter in suspension or solution, such, for in-

stance, as rain water, some few natural spring waters and, of course, waters which have been distilled. In this last means we touch upon one practically universal specific. However, it may not always be feasible either to set up or to operate a still of sufficient size or to depend upon it after installation, yet individuals or corporations owning several such vehicles certainly should supply their stations with pure water secured by distillation or chemical treatment, but under no circumstances should the chemicals be injected into the internal economy of the boiler. Granting that bad water is to be used, even occasionally, there are two precautions to be observed with the greatest fidelity, namely, to employ the best obtainable filtration of the water supplied, and to blow-down religiously after every run until the heater and mud-drum are cleared of all harmful contents.

Steam pressure, in motor-truck practice, should unquestionably be high—say 250 pounds, with high superheating, which latter can and properly should be accomplished by the design of the boiler; if not, then some form of separator in addition is certainly demanded.

As to the engine, one hesitates to lay down dicta additional to those above recited; still, simplicity and durability at least may be insisted upon. Twin or multiple-cylinder horizontal high-speed engines seem to be "indicated," as the physician would say, for sound designs; but beyond this it is not well to go, save to suggest that in the larger trucks a pair of such twin or multiple-cylinder engines, rather than a single such engine of equivalent power, would provide for many an unforeseen contingency which must inevitably occur in practical operation.

When it comes to valves and valve-gears, the cry should again be for simplicity and durability. Just here, I think the enormous demand for improvement in the steam engine may bring forth the unknown genius who may devise a movement and a means which shall give us a steam consumption in these diminutive motors comparable with that recorded by their larger counterparts; but one may be excused for maintaining an attitude of optimistic skepticism on this score. More will undoubtedly be accomplished in that direction by improvement in boilers and burners, which will enable still higher pressures to be attained than our assumed 250 pounds to the square inch.

In so disposing of the exhaust from our simple engine as to avoid annoyance to the public, we are forced to employ some form of muffler, and further to make such disposition of the vapor as shall render it invisible even in winter weather. Amongst the many

possible solutions of this feature of the problem the ingenious designer should find one or more means which will utilize some, at least, of the latent energy which, in the usual practice of wasting to the atmosphere, serves to account for the low efficiency of the steam system when compared with its theoretical possibilities.

Of lubrication, it is unnecessary to say more than that it should be liberal and automatic, for not otherwise will we render "fool-proof" designs which may otherwise be of superlative excellence.

Fittings should be beyond criticism in material, workmanship, and design, and none used where by the exercise of skill, experience, or ingenuity, it might be dispensed with. First cost should be no bar to the best. These conditions apply with equal force to all boiler, engine, or other trimmings and tools, for whatever purpose employed about the truck.

Locality, the personal equation, and the kind of goods hauled, must largely influence water and fuel-storage. It is, however, advisable to provide an excess of the latter over the former, based on the assumed average steaming radius, which might even be set as high as a ten-hours' run without placing too burdensome a dead load upon our mechanical horse. The supplying of both of these liquids (respectively to the boiler and the burner) should unquestionably be entirely automatic after starting, and the designer should be on his mettle until he has succeeded on these lines.

Air-storage and its after utilization for many purposes, such as operating all automatic devices, cleaning, starting, braking, steering, signaling, etc., constitutes a most satisfactory auxiliary in a motor vehicle, but it is by no means indispensable. The best method of obtaining such air-supply is a fertile field for the inventive mind and no doubt many excellent means have been, and will be, brought out.

Having now analyzed the means for generating our power, we pass naturally to the second phase of the problem, namely, the application of that power to the driving, steering, and braking of the truck under service conditions.

It is clearly evident upon a moment's reflection that the haulage of goods over our present streets and roads calls for only the most moderate speeds, save in exceptional cases, delivery wagons, so-called, being considered outside the scope of our inquiry. If we can do successfully by steam that which is now done by the draught animal we shall achieve a great forward step, which will increase in proportion as we excel the horse; but it is well to bear in mind that we have

no mean task in even equalling the horse, all things considered. The draught animal does his six to ten miles in the hour, though scarcely for a stretch of ten continuous hours, but we may count on the motor truck doing this and more with no evidence of fatigue. So it is clear that we may design the driving gear *without speed changes,* and safely calculate upon excelling the draught animal if our normal speed is, say, eight miles per hour. Having determined our driving speed, it is a short step to the power-transmission device, which again may be bounded by simplicity and durability, and should involve the minimum of friction and lost motion even under neglect and adverse conditions. The chain and sprocket must, I think, be rejected for this given service. Following our own criterion of simplicity, we should control the starting, stopping, backing, and possibly the braking, with one mechanical member which should be absolutely under the driver's control, and only operative with him in the cab.

In such heavy work as we are considering, the steering should certainly be done by power, or in any event should be self locking and call for no muscular effort from the driver. It will be noticed that if the many problems enumerated above are successfully solved by the designer, then, when our steam horse is ready for his day's run, one man only will be needed on the box—the same sober, intelligent, able-bodied, clear-eyed, prompt-acting driver who may have been in the owner's employ all his lifetime.

The absence of automatic features must inevitably necessitate the employment of an assistant, which cost can fairly be charged to the motor truck and credited to the horse since he requires but a single driver. It is almost superfluous to specify that vibration must be eliminated from the steering device, yet this seems not to have been done in numbers of pleasure vehicles now on the market.

There remains now but one operative feature to discuss, and that is braking. Here again, power of some sort should be employed, to render this the more certain when recourse is had to it, seldom though it be. An emergency foot brake in addition should also be figured in.

A word or two in the way of suggestion on signals may not be amiss, since we are aiming at present perfection. With an abundance of compressed air and steam at hand, there need be no difficulty in issuing warning notes; but it is surprising that designers have apparently overlooked or disregarded the fact that musical notes carry farther and are more readily heard than unmusical ones. A whistle

or equivalent device of pleasing as well as penetrating note should be adopted. As to optical signals, the use of the daylight-white acetylene leaves little to be desired and it should certainly recommend itself to all builders.

The design of the truck itself logically divides itself into wheels, tires, body, and springs, but they are best treated individually by treating them collectively. The horseless motor truck is unquestionably a more complex problem than even the locomotive, for the former has few, if any, of the fixed conditions under which the latter operates; it therefore behooves the designer of the truck to enter upon his problem with humbleness of spirit, not assuming omniscience in this branch of engineering unless he be prepared to defend his claims. In short, the fittest motor truck is likely to be the achievement of several associated designers, each expert in the particular art treated, and since the dray of to-day is so satisfactory an evolution of many minds working through many decades, I think we will do well to stick very closely to that. The dished wheel, for example, has proven itself the staunchest known form, certainly for American roads, and it is the dished wheel which compels the use of the bent axle whence results the unavoidable "undergather." This undergather necessitates, perforce, the rotation of the wheels upon rigid axles and prohibits the revolution of fixed wheels upon revolvable axles. In such trucks it has even been found that a certain amount of foregather between the forward halves of the wheels is necessary to secure the best results, thereby again complicating the problem of trying to revolutionize a machine already most fit. Like contentions hold true as to the springs and form of body or platform best adapted to carry a given kind of goods. For reasons such as these, it would seem to be the better part of wisdom to adopt the horse-truck as we find it to-day, to absorb it, and to adapt our motive power to this fretful porcupine rather than to attempt its reconstruction and be pricked for our pains.

In just one particular only do I think marked gains can be made, and that is in the tires. Unquestionably we should exhaust all our skill, study, and ingenuity in perfecting a tire, for the drivers at least, which shall exceed in durability and tractive power anything now in use. When we consider that the adhesion contact of the wheels varies from mud, or ice-lubricated asphalt grades, through hock-deep clogging clay, up to level stretches of gritty faced macadam—the road *par excellence* for heavy hauling—we understand both how difficult is the problem and how great the gain in the event of success. If, combined with a face of increased adhesive power we could at the

same time secure such resiliency as would relieve the truck-body and machinery from shock, we should very nearly approach the ideal. In France, I understand, rope-wound wheels are now in use—a most ingenious and effective tire, but one which would never succeed upon American roads owing to the rapid cutting and rotting of the fibres to which they would be subjected.

And now to sum up:—The logic of shrewd business and sound engineering seems to declare in no uncertain language that the fittest motor substitute for our present two-horse trucks, when employed in hauling goods over our present streets and roads by means of some known and tried power, must be: operated by steam generated by kerosene fuel under self-contained water-tube boilers, the boilers being automatically fed with water freed from chemical and mechanical impurities, and preheated to as high a degree as in any other branch of steam engineering; that no means or methods rejected in other fields of steam use shall be tolerated; that every refinement of the most advanced steam practice shall be employed when this is commercially and mechanically feasible; that we must seek perfection by the design of each element of our portable power plant by experts skilled in that particular means or method; that the horse-drawn truck of to-day has so assuredly proven its commercial and mechanical fitness that it must be adopted practically *in toto,* and our motive power in consequence must be adapted thereto; and, finally, that it shall be safe beyond peradventure—so simple as to be readily handled by the present driver, newly-enlightened—so durable as to represent a far better financial investment than when horse-drawn; thoroughly reliable in all weathers and seasons, on all roads and accustomed grades, with any contemplated load or no load; absolutely independent of any fixed base of supplies; flexible to manipulation in starting, stopping, steering, and backing; and lastly, so economical in fuel costs and in repairs as to be well within the reach of even the Yankee farmer.

EDITORIAL COMMENT

The true meaning of the steel situation is easily foremost in international importance. Active as was the stir made by the sudden entry of American locomotives, American bridges, American rails and ship-plates, into foreign and even into British markets, it was quietude compared with the reception given the announcement of the formation of the great American "Steel Trust." This is looked upon by some as a menace to the iron and steel makers of Europe, so close and so deadly that Britain should throw to the winds the fiscal and commercial policies under which she has prospered ever since her manufactures were founded, and try some artificial dosing from the protective-tarift bottle. Meantime, in the land of its birth, consumers shake their heads gloomily and look with apprehension to their own destruction through the giant greed of this new monster, which may dole out the necessaries of industrial life from its hoard only on such exorbitant terms that profits will be wiped out, prosperity will be strangled and progress stopped, Truly, a most pernicious organisation, destroyirg its own customers and markets at home in order to "dump down" its products at less than cost abroad!

* * *

It is rather curious to notice that the interest and excitement have been confined almost entirely to industrial circles; the financial world has viewed the movement with almost unmoved placidity. The promotors toss hundreds of millions of dollars from hand to hand: concerns whose individual capital would have staggered the financier of a quarter century ago are bagatelles in this stupendous game; finally the rustling securities are deftly gathered into one grasp—fourteen hundred million dollars of them—and Wall Street is scarcely flurried; general credits are undisturbed; the markets are relatively unexcited, and rates on money are unchanged. And yet the whole combination is exclusively a financial deal. It does not involve the creation of any new industrial undertakings, nor, in all probability. the elimination of any old ones. Indeed, it is not assuming much risk to venture the assertion that few industrial consolidations have involved less physical change than seems likely to attend the consummation of the present one. There was already a remarkably good understanding between the independent concerns which are now components of the giant consolidation. There was an exceptional harmony of co-operation along the whole line, from the ore miners to the contractors for finished steel structures. The combine has not thrust forward any Napoleon of manufactures—indeed, so far it has been characterised by a negative influence only on industrial leadership—the apparent retirement from activity of Andrew Carnegie, the most commanding figure of modern times in the practical advancement of iron and steel making. His most trusted lieutenants remain, but essentially the movement means the passing of the dominance of the manufacturer and the ascension of the throne by the financier. It means the subordination of the effort to surpass by competition, to the effort to dominate by regulation. And, as our esteemed contemporary, the New York *Journal of Commerce*, says in one of the ablest reviews of the subject which has come under our notice:

> "The world has not seen progress and success achieved without competition. It is not prepared to say that this cannot be done, but it is excusable for regarding experiments in that direction with skepticism. * * * Mr. Carnegie's busi-

ness sagacity has done more than anything else since Bessemer's invention to cheapen steel, expand the market for it, and create the present enormous profits of the business. Mr. Carnegie has been a competitor from the beginning and he has been strictly and exclusively a manufacturer and not a financier. He has generally kept out of combinations to reduce competition; he broke the steel-beam pool and the steel-rail pool which sought to restrict production and keep prices up, and from the beginning his policy has been to control everything from the ore bed and the freight car up to the finished product. The present combination has been created to reverse Mr. Carnegie's policy."

What direction the "regulation" will take will be a study of intense interest. If it be in the direction of adjusting output to demand, and avoiding the alternating conditions of over supply and under production whose baneful effects Mr. Hull discussed lately in these pages, it will be, so far, widely beneficial. That it can go much farther is not clearly apparent. If the Trust is to do a full volume of business, there cannot be an extensive abandonment of existing plants. Readjustment and condensation of organisation has the marked attendant disadvantage of setting free much of the individual talent and enterprise which built up the present industry—and it must not be forgotten that the United States Steel Corporation, huge as it is, by no means monopolises the business of the country. There is many a giant killer yet at large and unafraid.

* * *

And after all, are any economies of administration likely to offset the extravagances of capitalisation by which the plans so far have been characterised? As for operation, there seems to be no room for doing away with intermediate or "middle-man's" profits. Every profit now paid by the iron, from the time it is taken out of the ground till it is left in the finished bridge, is retained and augmented, in the form of dividends on the proportionate representation of the new stock. The steel product must pay all it ever did, to builder, steel maker, blast-furnace man, ore-carrier, miner—apparently must pay more than it ever did. Where is the economy of production to come from—where the advantage to the consumer or the menace to the outside steel maker? The colossal combination may bring forward what the *Journal of Commerce* terms an "industrial Cromwell," capable of making the "other members exert themselves as competition made them in the outside world." The struggle to satisfy shareholders, expectant of dividends even in adverse times, may supplement the still existent competition from without and prove powerful enough to keep the industry advancing toward greater and greater economy in manufacturing, of which economy the world at large will be given a considerable share. It has been so with the Standard Oil Company, in spite of lack of competition. But it looks very much as if the American steel trade had turned away from its old leading principles, and further had practically put upon itself a burden of fixed tonnage charges, as hampering in external competition as those which Mr. Phillips, elsewhere in this number, lists against the British steel maker. The profits per ton of finished product which the new corporation must earn, to pay interest on its bonds and dividends on its shares, work out to an alarming figure.

The names of the financial sponsors of the enterprise make skepticism appear the height of audacity; nevertheless it is very hard to hold a firm faith that the earnings will be sufficient when the present times of prosperity yield to the industrial depressions which heretofore have periodically affected both Europe and America. And already clouds are rising over Germany.

* * *

The power of so stupendous an aggregation of capital is impressive—and it is stupendous even assuming, as asserted, that the total actual values of the properties amalgamated would approximately equal the bonded indebtedness only. The possible strength of a unified and centralised control of all the elements of steel making, from the ore and coal in the ground to the finished product or structure, is also enormous. But it is not

apparent that the change from former conditions should infect with panic either consumers in America or producers in Europe. The former may be reasonably sure of a commercial policy as enlightened as that heretofore characterising the dealings of the steel producers, and of greater stability. It is a pretty safe guess that the Trust will endeavour to stimulate consumption and to promote the prosperity and hence the buying power of the consumer—not to narrow its markets by an inordinate advance in prices. The British iron and steel trade will see more clearly the competition they have to meet, but it is not quite apparent that they will be in any worse position to meet it. Their dangers will be, as they have been heretofore (Mr. Phillips sums them up most succinctly in this number, page 173 to 186,) the greater advantages possessed by the United States in respect of natural resources and in respect of the general adoption of labour-saving appliances and of methods ensuring the utmost of economy.

The former, perhaps, constitutes a permanent difference. The latter certainly does not. Every economical appliance and advanced method at mine, docks, blast furnace, steel works, and mill can be adopted by British masters. There may be deplorable opposition by labour to overcome, but overcome it will be—as it always has been under analagous conditions. And here Britain has an enormous margin of potential economy which she may make actual. Her possibilities in this direction are vastly greater than those open to America, for she has these yet unseized opportunities still available, and after that an ability to push forward along advanced lines if only she is keen to recognise and adopt the most advantageous modern methods. If, while handicapped by antiquated and wasteful ways of doing things, she is yet holding a leading place as the world's workshop, need she despair of the results which will follow when she has fully equipped herself according to the latest ideals of economical mechanical production?

It would be foolish to maintain that the phenomenal natural resources of the United States do not give them a permanent industrial advantage, or that there is not a tendency for industrial ascendancy to pass to the land so endowed. The point is that this is not the whole of the case nor the only important consideration. National temperament, adaptiveness, stability of character and institutions, commercial ability, political and economic soundness, all are influential and the result is a product of all the factors. Over confidence in the strength of one's own position and indifference or inattention to the qualifications of rivals are the most disastrous attributes. England is suffering more from her long obliviousness to the possibillty that she could have a formidable rival than she is from the opening of the Minnesota iron mines or the Pennsylvania coal fields. Her awakening has been startling, but promises to be thorough. With her magnificent political stability, her sound economic system, her marvellous commercial system and her dogged courage—and, after all this, with the "cashing in" of her yet unrealised asset of possible labour-economy—she is so far from "decadent" that the suggestion is ridiculous. It is not at all probable that she can retain the wholly disproportionate share of the world's engineering trade she once enjoyed. The demands are now too great for her capacity, developed to its utmost, to satisfy as large a fraction of them as once she did. The United States, Germany, possibly other National "workshops" not yet fully organised, must be called in to share in the stupendous undertaking. But this is anything but retrogression. And next to her own interest in maintaining her position lies America's interest that she should do so, for she is America's best customer and the continuance of that custom depends upon England's retention of her industrial activity and wealth.

* * *

There is immediate and crying need for remodelling British steel-making practice, beginning with the ore in the ground

and the system of land tenures under which mines and works are operated. The defects of the present order and their possible remedies, as they appear to an earnest and patriotic Englishman keenly interested in the prosperity of the steel industry in his own country and intimately familiar with the working of the present arrangements, will be formulated in Mr. Phillips' second article on "Britain and Her Competitors in Iron and Steel Making," to appear in our June issue Whether or not his solution be accepted *in toto*, the ills must be recognised and by some adequate means abated.

This done, Britain may still find profitable markets for all she can produce But supposing even American steel, in certain grades and under certain conditions, can be laid down in Britain at a lower cost than it can be made at home Will not the engineering trades gain what the ironmasters lose? Britain already imports two-thirds of her iron ore. It might mean painful readjustment, but would it mean ruin, to go one step more, and import the raw material a step farther along in the process of manufacture?

The probability of a positive decline in British steel manufactures is not great; but the attempt to avert it by a tariff duty on foreign steel imported into the United Kingdom would simply throw the game into the hands of the United States and Germany. With Britain self-excluded from purchasing the best and cheapest steel on an equal footing, the markets of the world would be wide open to her competitors. Probably they would cheerfully approve the policy, and be quite satisfied with the exchange of fields. America prospered for some years in spite of protection, because of the enormous home territory to be settled, improved, and developed. There were markets for everything the manufacturers could produce, and the general inflation was not disastrous because of the small area of contact with the rest of the world. There is no possible parallel between such conditions and those controlling the industries of Britain. And there is no likelihood that those controlling Britain's fiscal policy will depart from the long triumphantly successful policy of free trade, under which she has again and again adjusted herself to changing conditions and become the world's greatest seller because she has ever been the world's ablest buyer—because she has worked under conditions of assured stability and concentrated her efforts on the thing whose accomplishment yielded the largest proportionate returns.

* * *

In recapitulation, there is no evident reason why the formation af the United States Steel Corporation should menace the trade at home or abroad. It should steady production and prices. It does not cheapen mining, transport, smelting, or steel making. It does charge itself with the necessity of earning a handsome, or at least a sufficient, profit on every ton t can make and sell. It does not eliminate competition, except certain immediate competion which was threatening other interests very important to some of its promotors. A very large porportion of the steel and iron production of the United States remains in the hands of owners outside of the trust—owners of strength and ability. And there is that large element of talent and enterprise, which may be "turned out of a job" in the reorganisation, to be reckoned with somehow. Possibly in this unquenchable and unsilenceable competition lies the strongest saving hope for the continued advance of the art of steel making in the United States.

* * *

In view of the invasion by Germany and America of British markets for steel and iron products, it is interesting to observe that there is one market at least which is fairly well within British control—that of structural material for ship-building. In this industry, as ever before, Great Britian continues to hold her great supremacy, and in this, at home on the Clyde, the Tyne, and the Thames, there will be a market for British iron and steel.

The Navy estimates for construction work amount to £9,003,256, of which

about £8,500,000 is for work actually under way, nearly £7,000,000 being for machinery being built by private firms for hulls in Government yards. In addition to this is the great amount of construction work for the merchant marine, a market which includes replenishment of existing fleets and extension for new requirements. All this is practically in British hands, for the German yards are not yet capable of supplying the demands of their own country, and their entrance into British trade is not to be considered.

It is not to be understood that the shipbuilding industry is the only one to which Britain may look for her steel trade, but it is the one branch in which competition is least to be met. In other lines, however, the effects of competition may work much good, if only to stimulate the development of the most modern methods and the greatest economies in manufacture. It never does harm to learn lessons from one's rivals, and it is altogether possible that the close competition between England and America may result in such a further development of Britain's iron and steel industries as to react still more favourably upon the relation of the home industries of structural material and shipbuilding, and to strengthen their position as a bulwark of British industry.

* * *

Among engineering of works of magnitude of recent construction there appears to be a tendency to use the viaduct where ravines are spanned, and to limit the arch to locations in which streams are in the way. It is the opinion of some able engineers, however, that the steel arch, when properly designed and constructed, is really stiffer and more economical than the viaduct, even though the points of support are much farther apart. Indeed, it is for great heights and wide spans that the arch shows it superiority, comparative designs, in which the weights have been carefully worked out, showing a decided advantage for the arch over the viaduct, when depths of 200 to 300 feet have to be spanned.

From æsthetic considerations there are but two forms of bridge which are agreeable to the eye, the suspension and the arch (these being really the one the inversion of the other), while the girder and the cantilever, however correct they may be constructively, are far from pleasing in appearance. It is interesting to observe that in many cases of bridge replacement the new construction has been distinctly more agreeable to look at than the older form which it superseded, and when it can be shown that the form which looks the best *is* the best, there is every reason to feel a sense of satisfaction that the canons of beauty and utility have been obeyed together.

* * *

The summary of the engineering progress of the past century by Mr. Thomas Curtis Clarke, reviewed at length elsewhere in this issue, emphasises a cause of the development of engineering which cannot be too strongly stated It is the publicity which is given to methods, processes, and results, which enables the modern engineer to accomplish so much more than his predecessor. Under the old system of keeping the knowledge of the profession as an "art or mystery," each man had to learn over again for himself much that his immediate associates knew already, but carefully cherished as a part of their private possession, and the effect of this secretiveness upon the development of the profession was most repressing. To-day the multitude of technical journals and magazines is filled with the open record of the practice of the greatest and ablest minds in the profession. What would formerly have been considered as shop secrets of great value are now printed openly in publications especially known to reach the very men desirous of obtaining such information, and strange to say, the result is a general advance in which all partake, and each receives far more than he gives.

Mr. Clarke especially notes the benefit to the profession of the comparatively modern idea of publishing indexes and digests of the technical articles in the current periodicals, and fully believes in the important part which these have had in recent engineering progress. When con-

sideration is given to the immense amount of labour which can be saved by a judicious use of THE ENGINEERING INDEX, it is a matter for surprise, not that it has been such an efficient aid in developing the work of the engineer, but that it is not far more generally used than it actually is. True, many able men examine it regularly for articles relating to their especial work, and in the card form it is found in some libraries, side by side with the cases containing the periodicals indexed; but in far too many instances this invaluable aid to investigation and the saving of labour is neglected.

When it is realised that by glancing over about thirty pages the whole field of technical literature of the month, including the important articles in nearly two-hundred publications, can be noted, and the special papers in one's chosen profession found, some idea of the help of such a concentrated mass of information is obtained. When, still further, it is understood that the special papers desired can be had upon order, without the necessity of subscribing for any period of time to the publication containing the INDEX, or even doing more than writing a number and an address upon a coupon and dropping it into the post with a sum trifling in comparison with the value of the information obtained, then one begins to understand what it means to have done almost automatically for him what he could never spare either the time or the money cost to do for himself.

"Science," according to the masterly definition of Lord Brougham, "is knowledge reduced to a system." THE ENGINEERING INDEX has reduced the assimilation of the contents of the technical press to a system, and in so doing has contributed in no small degree to the advancement of engineering, upon which so great a share of our material progress depends.

* * *

Another factor which has done much to advance the science of engineering along the line of publicity, so vital to all true knowledge, is the work of the engineering institutions and societies.

Nearly every branch of the profession now has its representative body, and in meetings more or less frequent the great works of members in all parts of the world are discussed and examined. Handsome houses are built to provide meeting places and shelter for libraries and collections, and membership in such institutions is coveted as the mark of professional eminence and standing.

The result of all this has undoubtedly been for good, however strongly opposed it is to the former idea that knowledge was a cult to be maintained as the property of the few. Although membership in recognised institutions is to be had only after the production of evidence of ability and standing of the high standard required, yet the provision of various grades of membership renders it possible for all, who are in any way qualified to profit by the proceedings, to take part in them.

The result has been of immeasurable benefit to the work of the engineer and to the standing of the profession. A century ago, an engineer, in the modern sense of the term, was regarded as little more than an ordinary mechanic, unless by some patronage or especial circumstances he was forced to the front. To-day membership in the great professional societies is in itself a warrant of social standing. At the conventions of the various societies the members have been accorded recognition by royalty and authority in many lands, and within the past few years the interest taken in the work of such bodies by the Queen of England, the King of Sweden, the President of the United States, and the President of France, shows how closely the work of such bodies is related to that of government. With this has naturally come a strengthening of international relations, and the affiliation between the engineering institutions of England, America, France, and Germany has been shown and appreciated at the gatherings at Paris and elsewhere in the past year.

It is freedom of thought which leads to freedom of action, and liberty in engineering matters has truly been the most effective factor in the development of the past century.

REVIEW OF THE BRITISH PRESS

The Water-Tube Boiler Report.

SIX months ago there was noted in these columns the appointment of a special committee by the Admiralty to inquire into the question of water-tube boilers in the Royal Navy, and at that time it was said that there was a possibility that the many conflicting and doubtful reports would be superseded by positive data from which both engineer and layman might draw definite conclusions.

This was followed by the exhaustive study in the issues for November and December, by Mr. B. H. Thwaite, of water-tube boilers in general, with a critical comparison both of the type and of special forms, with the shell boiler. Now we have the interim report of the Admiralty committee, and from the text of the report itself, and from editorial comments by the technical press, we may review the situation as it is officially placed before the public.

At the time of its appointment the committee was instructed to report upon three distinct points; whether water-tube boilers in general were more suitable than cylindrical boilers for naval purposes; whether the Belleville boiler was the best form for the Navy; and, what general advice and information could be given upon the subject of boilers for naval service.

These points have been duly considered in order. Upon the first the committee utters no uncertain sound:

"The committee are of opinion that the advantages of water-tube boilers are so great, chiefly from a military point of view, that, provided a satisfactory type of water-tube boiler be adopted, it would be more suitable for use in His Majesty's Navy than the cylindrical type of boiler."

That is to say, water-tube boilers are all right, if we can only get a good kind. That a good kind has not been already obtained in the Belleville, is also apparent from the statement of the committee on the second point.

"The committee do not consider that the Belleville boiler has any such advantage over other types of water-tube boilers as to lead them to recommend it as the best adapted to the requirements of his Majesty's Navy."

So far as installations already completed, in progress, or contemplated are concerned, the committee recommends:

"As regards ships which are to be ordered in the future: that Belleville boilers be not fitted in any case. As regards ships recently ordered, for which the work done on boilers is not too far advanced: that Belleville boilers be not fitted. As regards ships under construction, for which the work is so far advanced that any alteration of type of boiler would delay the completion of the ships; that Belleville boilers be retained. As regards completed ships: that Belleville boilers be retained as fitted."

This, then, is the finish of the Belleville boiler in the Royal Navy, for there can be no reasonable appeal from such a positive decision, coming from such a high tribunal. Passing then, from the conclusions, it may be advisable to examine somewhat into the facts upon which they are based.

First, as to the superiority of water-tube boilers, over cylindrical boilers for naval use, this is really the most important point in the whole report. It had been practically anticipated that the committee would condemn the Belleville boiler, at least for future installations, but it was feared in some directions that the condemnation of one form might drag down the whole class with it. It appears to be well understood, however, that water-tube boilers may be divided into two classes; one, consisting of the Belleville, the other consisting of all other water-tube boilers. The highest French authority on marine boilers, M. Bertin, divides water-tube boilers into three classes; those with limited circulation, in which he places the Belleville; those with natural circulation, such as the Niclausse, Babcock & Wilcox, etc.; and those with accelerated circulation,

such as the Thorneycroft, Yarrow, and other small-tube boilers.

Herein lies the real cause of the unsatisfactory working of the Belleville boiler, its defective circulation. The construction is sufficiently well-known to render this defect to be easily understood. Each element, consisting, as it does of a zig-zag built-up tube about 150 diameters in length, with a restricted water supply at the lower end and a free outlet at the upper, cannot possibly deliver the steam which it can make without carrying with it much of the water. Speaking of the boiler as made in 1869, M. Bertin says: "The boilers were irregular in working, owing principally to the steam not being able to get away with sufficient freedom. The whole of the water was at times forced up from the lower tubes, and on one occasion all the tubes in the lower rows, which were full of steam, became red hot." We have been given to understand that this defect existed with the earlier boilers only, but there is no reason why the same action should not take place with the Belleville boiler as built to-day, and the behaviour of the boilers which have been installed in the Royal Navy, so far as has been made public, indicates that such action is just what does take place. In this matter the report of the committee may be literally quoted.

"The following points in relation to the construction and working of the Belleville boiler to constitute practical objections of a serious nature: (*a*) The circulation of water is defective and uncertain, because of the resistance offered by the great length of tube between the feed and steam collectors, the friction of the junction-boxes, and the small holes in the nipples between the feed collector and the generator tubes, which also are liable to be obstructed, and may thus become a source of danger. (*b*) The necessity of an automatic feeding apparatus of a delicate and complicated kind. (*c*) The great excess of the pressure required in the feed pipes and pumps over the boiler pressure. (*d*) The considerable necessary excess of boiler pressure over the working pressure at the engines. (*e*) The water gauges not indicating with certainty the amount of water in the boiler. This has led to serious accidents. (*f*) The quantity of water which the boiler contains at different rates of combustion varying, although the same level may be shown on the water gauges. (*g*) The necessity of providing separators with automatic blow-out valves on the main steam pipes to provide for water thrown out of the boilers when speed is suddenly increased. (*h*) The constant trouble and loss of water, resulting from the nickel sleeve joints connecting the elements to the feed collectors. (*i*) The liability of the upper generator tubes to fail by pitting or corrosion, and, in economiser boilers, the still greater liability of the economiser tubes to fail from the same cause. Further: (*k*) The upkeep of the Belleville boiler has so far proved to be more costly than that of cylindrical boilers; in the opinion of the Committee this excess is likely to increase materially with the age of the boilers. (*l*) The additional evaporating plant required with Belleville boilers, and their greater coal consumption on ordinary service as compared with cylindrical boilers, has hitherto nullified to a great extent the saving of weight effected by their adoption, and, in considering the radius of action, it is doubtful whether any real advantage has been gained."

Among the boilers held under consideration as possibly available for the naval service, are named the Babcock & Wilcox, the Niclausse, the Dürr, and the large-tube Yarrow boiler. Of these, the Babcock & Wilcox is widely known and used in land service, and as modified for marine use appears to be entirely free from the defect of restricted circulation. It has given a good account of itself in some vessels of the American navy, and is recommended by the committee for early trial. The Niclausse boiler also provides for good circulation, and is, in fact a nest of Field tubes placed at a low angle, with good connections for the entrance of water and the discharge of steam. The Dürr boiler is practically identical in principle with the Niclausse, differing in minor details only.

Water tube boilers have not given as good evaporative results as cylindrical boilers, and attempts have been made to improve the performance by the addition of economisers. This method does not meet with the approval of the committee, and the recommendation is very properly made that economisers be abandoned, and that better efficiency be obtained by securing better

combustion. This means increased combustion space, and a greater distance between firebars and tubes, a most sensible recommendation.

It is a question whether the small-tube boilers ought not now to be given an opportunity to show to what extent they are available for large vessels. Boilers of the Yarrow and Thorneycroft type are constructed in units of more than 1,500 h. p., and it appears altogether possible that designs originally supposed to be mainly suitable for torpedo boats and destroyers, may yet be found applicable to larger vessels.

It is interesting to note that the committee recommends the use of cylindrical boilers for the supply of steam to the auxiliaries, where a large proportion of the fuel consumption must be charged.

Automobiles in Warfare.

EXPERIENCE with animal traction in recent military operations have called forth various suggestions that mechanical devices might be more effective, and in certain instances traction engines have been satisfactorily employed for hauling artillery and supply trains. In a paper recently presented before the Royal Artillery Institution, Major H. A. Bethell described a form of automobile adapted for field artillery service, and discussed the advantages and defects which such vehicles might possess.

For artillery service, steam appears to be the only motive power at present applicable, and for such service many of the objections urged against steam for ordinary uses do not apply. For rough ground the three-point suspension is advocated, although it is objectionable so far as side-slip on muddy roads is concerned. The running gear should include a powerful slow-speed gear for use on bad ground, and a winding drum and wire rope for use in warping the vehicle out of difficulties. No especially new details of motive power are suggested by Major Bethell, it being assumed that the boilers and engines of such makers as Thorneycroft Simpson & Bodman and others possess all the necessary qualifications.

"For artillery purposes, a motor would be constructed to carry one hundred rounds of ammunition and six men, and the gun would be limbered up to it in the ordinary way. Presumably the gun would be a heavy high-velocity fifteen-pounder quick-firer, with axle-tree shields, similar to the guns now being issued, but more powerful. Waggon bodies similar to the present ones, but carrying one hundred rounds, instead of sixty-four, would be drawn by motors exactly similar to the gun motors, and interchangeable with them. This would give three hundred rounds of ammunition per gun in the first line, and detachments of twelve men per gun besides the drivers. Five other cars, similar in construction, but different in fittings, would carry the five officers, with the range-takers and battery staff. These cars would be capable of pulling guns if required. A battery travelling kitchen, officers' mess car, and an advance and rear guard of cyclist scouts, would complete the turn-out.

"Now if the motor car will do what its advocates claim for it, a battery equipped as above would have many advantages over a horsed battery. It would have more powerful guns, twice as much ammunition, and would carry its own baggage; it would, in fact, be complete in itself. Such a battery could march twelve miles an hour, or one hundred miles a day. It could move nearly as fast as a horsed battery over ordinary European fighting ground, *i. e.*, cultivated fields; it could move at three miles an hour over ordinary rough ground, and only really bad ground, such as a field battery traverses at a walk with detachments dismounted, would be impassable to it. It would require a less number of men than a horsed battery, and cost considerably less; it would also occupy less space on the road when marching."

There are naturally numerous objections to be made to mechanical traction for artillery, but Major Bethell argues that these are hardly greater than those known to exist in connection with animal traction. So far as liability to breakdown is concerned, experience with steam motors has shown that they are comparatively free from breakdowns, and that casualties are almost always due to mistakes of drivers. Sinking in soft ground may be prevented by the use of wide tyres. Danger of disablement in action is proportionally less than with horses, the boiler and vulnerable parts offering about the same exposure to fire as a single horse, while the crippling of three

horses which would permanently disable a gun, is about as probable as the hitting of a boiler, and the two are about equivalent. The time in starting is estimated at about five to ten minutes in favour of horses, and in the case of the motor traction the danger due to horses becoming unmanageable is absent.

The first cost of the motor vehicle is estimated as £1,755 as against £2,997 for a team of six horses, both estimates being based on six years' service. The cost of actual operation of the motor vehicle would depend much upon the supplies of fuel and water these being readily available in most places. In waterless districts extra water tanks would have to be included, but the motor vehicle would be far better able to carry its water supply than would the horse team.

"Up to the present no trials of motors across country have been made, nor have any cars been built with a view to military requirements. No one has asked for them, and it is not the business of manufacturers to build experimental vehicles to meet a problematical demand. But several of our leading car-builders are of opinion that there is no very great difficulty in complying with the conditions proposed; and if the War Office were to offer any encouragement—say, an order to six leading manufacturers for a car each, built to Royal Carriage Department design, modified to suit manufacturing specialties—this offer would find a ready response."

The Electrical Power Bills of 1900.

LAST September the subject of the electric-power bills under consideration by the Select Committee of the House of Commons was discussed in these columns, and frequent reference has since been made to the hampering influence which adverse or dilatory official action has had upon the development of electrical undertakings in Great Britain. Referring to the passage of four important bills for such undertakings at the recent session, Mr. W. L. Madgen presented before the Institution of Electrical Engineers a paper examining the conditions of the industry before and after the passage of the bills, with some excellent comments upon the relation of the electrical industry in Great Britain and other countries.

Mr. Madgen shows that it is to no lack of ability that Britain is so behindhand in electrical undertakings, and mentions the work of Hopkinson, Swan, Ferranti, and others to emphasise this fact. The real reason, as he emphatically joints out, is due to silly legislation by Parliament and obstruction by numerous local authorities entrusted with arbitrary powers; and to a class of quasi-officials and their associates to whose direct monetary advantage it is that an opposition should be entered to every project in which they are not employed.

The Act of 1870 with its notorious section 43, providing for the purchase of a tramway at the expiration of twenty-one years at a price based solely upon the instant value, without regard for future profits, etc., effectually stifled tramway development uptil the Act of 1888 gave a trifling relief by extending the period from twenty-one to forty-two years. Electric power distribution is still governed by the Act of 1882, passed at a time when the distance to which energy could be delivered did not exceed the limits of a single town, and when modern supply in bulk over many miles was not possible.

During the six valuable years between 1882 and 1888 Germany and America, under far more favourable conditions, have gone ahead with home undertakings which have given them an experience and equipment which laid the foundations of their great export business in electrical plant and accessories, the consequences of which Britain is now feeling. America and Germany now hold the great bulk of the export trade of this character, not only to the countries of Europe and to South America, but also to British colonies and the United Kingdom itself.

The passage of the four bills of 1900 show a slight sense of comprehension of national backwardness in that, with certain limitations the companies may proceed to do what in other parts of the world they have been encouraged to do.

The absence of great electrical undertakings in the United Kingdom has not been on account of any difficulty or impossibility on the engineering side, or from any lack of suitable conditions, but is wholly due to the causes above mentioned. Mr. Madgen gives in parallel columns the relative ad-

vantages and disadvantages of supply from main power houses over large areas and from small local stations, and shows nine distinct advantages for the large stations and two minor disadvantages, while for the local stations there are no advantages to be found, and eight great disadvantages.

It is useless to endeavour to build up a business in Great Britain when such a severe handicap is officially put upon British industries, and it is no wonder that the position of the nation is a humiliating one.

The Efficiency of Marine Boilers.

WHILE the water-tube boiler will doubtless soon become the boiler for naval service, the cylindrical tubular boiler will probably maintain its assured position in the merchant service for a long time. For this reason the paper of Mr. G. M. Brown, upon methods for increasing its efficiency, presented before the North-East Coast Institution, is important. As Mr. Brown says, there has been little done to the cylindrical marine boiler during the past twenty years except to increase its strength to withstand the increased pressure demanded. The marine engine has been improved in many ways, and it is time the boiler had received some attention.

The boiler is intended to abstract the heat from the gases and transfer it to the water to be evaporated. This being the case improvement should be looked for in devices to secure good combustion, and to permit as little heat as practicable to go up the funnel.

Taking up the last point first, it appears that the proportion of heat absorbed by the boiler may be increased in two ways, by increasing the proportion of heating surface, and by rendering certain portions of that surface more effective. Heating surface may be increased in boilers already constructed, by placing feed-water heaters, or economisers, in the uptake, and also by using tubes with "extended" fire surface, such as the Serve tube with projecting internal longitudinal ribs. Such ribs increase the heating surface about 75 per cent., and their use has shown a marked increase in efficiency.

Much of the usual heating surface in tubular boilers is ineffective, and experience has shown that the lower rows of tubes receive but a small portion of the hot gases, the draft tending so strongly toward the upper tubes that the lower ones soon become filled with soot and fine ash. Attempts have been made in stationary practice to improve upon this condition of affairs by making the lower tubes of larger diameter than the upper ones, and Mr. Brown advocates the use of "retarders" in the upper tubes to accomplish the same object.

He gives the results of various experiments made with retarders, from the early attempts of Isherwood, to the recent ones of Scott, the latter showing especially the advantages derived from a proper distribution of the retarders to compel a greater portion of the gases to flow through the lower tubes.

The importance of providing ample combustion space is also emphasised, the advantages of large rear combustion chambers being shown.

In addition to the use of feed-water heaters and economisers, the discharge gases may be employed to superheat the steam, this formerly having been the general practice, and now being effectively revived. Recent experiments on the steamer "Inchmarlo," provided with superheaters, showed a temperature of waste gases of only 380° F., and a consumption of only 0.97 lb. of coal per indicated horse-power-hour.

Combining good combustion, ample heating surface, and appliances for abstracting heat for the waste gases, there is every reason to believe that high boiler efficiency can be secured.

The Marine Steam Turbine.

THE steam turbine has been the object of much attention ever since the early experiments of Mr. Parsons attracted attention to the remarkable results attainable, and hence the paper recently read by him before the Institution of Engineers and Shipbuilders in Scotland, upon the application of the steam turbine to fast vessels, is noteworthy.

Mr. Parsons tells how the steam turbine was originally devised for the purpose of providing an engine of high rotative speed for the purpose of direct driving of dynamos, and as the best turbine speed was too high this also involved the design of a high-speed dynamo.

In the year 1884, a compound steam tur-

bine engine of 10 h. p. and a modified high-speed dynamo were designed and built for a working speed of 18,000 revolutions per minute. This machine proved to be practically successful, and subsequently ran for some years doing useful work, and is now in the South Kensington Museum.

This turbine engine consisted of two groups of fifteen successive turbine wheels, or rows of blades, on one drum or shaft within a concentric case on the right and left of the steam inlet, the moving blades or vanes being in circumferential rows projecting outwardly from the shaft, and nearly touching the case, and the fixed or guide blades being similarly formed and projecting inwardly from the case and nearly touching the shaft. A series of turbine wheels on one shaft were thus constituted, each one complete in itself, like a parallel flow water turbine, but unlike a water turbine, the steam after performing its work in each turbine passed on to the next, preserving its longitudinal velocity without shock, gradually falling in pressure on passing through each row of blades and gradually expanding. Each successive row of blades was slightly larger in passage-way than the preceding, to allow for the increasing bulk of the elastic steam, and thus its velocity of flow was regulated so as to operate with the greatest degree of efficiency on each turbine of the series.

Experience with this early machine showed the advantage to be attained by making larger engines, and in 1888 several machines of 120 h. p. were made, while in 1892 a 200 h. p. steam turbine was arranged to be worked in connection with a condenser. This turbine was tested by Professor Ewing, and with a steam pressure of 100 lb., moderately superheated, and a 28 ins. vacuum, a consumption of 27 lb. of steam per kilowatt-hour was obtained, this corresponding to about 16 lb. per indicated horse power. A number of such turbines have since been made for direct electric driving, and a generating set of 1,200 kilowatt capacity of this type, recently constructed for the corporation of Elberfeld, Germany, showed a performance equivalent to a consumption of 11.9 lb. of steam per indicated horse power, a result surpassing the records of the best steam engines of this size.

Mr. Parsons, however, discussed mainly the application of the steam turbine to marine purposes, and after detailing the early experiences with the Turbina, and discussing the problems of "cavitation" encountered with the action of screw propellers at high rotative speeds, he proceeded to outline the design for the application of the turbine to large liners and cruisers.

A vessel now under construction by Messrs. W. Denny & Bros., of Dumbarton, is 250 ft. long, 30 ft. beam, and 17 ft. 9 ins. depth, and is to be fitted with the following machinery. There will be three turbines, fitted to three separate shafts, the high pressure turbine being on the middle shaft and the two low-pressure turbines on the two outer shafts. Inside of the exhaust ends of the low-pressure turbines are placed the two astern turbines, which operate by reversing the direction of rotation of the low-pressure motors and outside shafts. When going ahead, steam enters the middle, or high-pressure turbine, where it is expanded about five times, and then passes through the low-pressure turbines, in which it is expanded 25 times, thus giving a total expansion of 125-fold, instead of about 16-fold, as in triple-expansion reciprocating engines. Since the outer shafts can be rotated in either direction all the manoeuvring power of a twin-screw vessel is obtained.

This vessel is intended for regular passenger service, in which the full speed will be constantly demanded, but for cruisers, in which a cruising speed, much lower than the economical speed of the turbines will be generally required, a modification is arranged. At cruising speeds, the revolutions of the turbines fall well within the limits of speed of small reciprocating engines, and such engines may therefore be directly coupled to the main turbines, and work in conjunction with them. The small triple-expansion reciprocating engines take the steam directly from the boilers and expand it down to about atmospheric pressure. It then passes to the high-pressure turbine and thence to the low-pressure turbines to the condensers. When somewhat higher speeds are desired, a little boiler steam is admitted to the turbines, and when still higher speeds are demanded and the revolutions become too high for the reciprocating engines, the latter are uncoupled, and the turbines are given full steam and power.

This combination of reciprocating engines and turbines is only needed for cruisers which are operated for long periods at slow cruising speeds. The turbines alone have their full measure of economy from half to full power, and it is only when the cruising speed falls to nearly one-half full speed and the horse power to one-eighth full power, that the economy of the turbines requires assistance. Such a combination is entirely unnecessary for passenger engines and ocean liners.

The simplicity of construction and arrangement of turbine machinery for an Atlantic liner of 20,000 to 30,000 h. p. over that of reciprocating engines is very apparent. The advantages to be realised in actual service may be summed up as follows:

Increased speed for the same boiler power, due to considerably reduced weight of machinery, and increased economy of steam; or, conversely, same speed with reduced boiler power and reduced coal consumption.

Absence of vibration, giving greater comfort to passengers and diminished strains on hull.

Increased cabin accommodation, due to smaller space required for machinery.

Less upkeep in machinery, and smaller engine-room staff.

In view of the extent to which undertakings are now being made to introduce the steam turbine upon passenger vessels, we may soon know from actual experience the extent to which these features can be realised in practice.

Electrical Power in British Works. - ALTHOUGH there have been many papers and articles upon the advantages of direct electrical driving of machinery in workshops, there is always something more to be said, and until the complete or general substitution of electricity for shafting, belting, and gearing is effected the subject will be one for discussion.

A very excellent paper dealing with the question from a practical standpoint, was recently presented before the Gloucester Engineering Society, by Mr. W. Geipel, and published in the *Electrical Review,* from which some abstracts are made.

The older arrangements of power distribution may be classified into three groups; the use of one large engine, with shafting and belting transmission, the use of a number of separate engines, with steam transmitted through long pipes from a central battery of boilers, and the use of a number of boilers and engines scattered over the works. The consequent losses vary according to the system employed.

When a single engine is used, the losses in transmission are those due to journal friction, stiffness of belts or ropes, and weight of material kept in motion. Investigations of many cases in different kinds of work show these losses to range between 14 and 81 per cent. of the total power of the engine, an average for heavy work being 62 per cent. and for light work 52 per cent. When the steam is transmitted long distances to the engines, the losses are those due to condensation in the pipes, and those due to the fact that the small engines are not so economical as a single large engine of equivalent power. The loss in steam pipes may be partly prevented by jacketing, but this is only a partial relief. Mr. Geipel estimates that the loss in pipe condensation is the equivalent in steam of half-a-ton of coal per annum for each square foot of pipe exposed to the atmosphere, while with the best lagging the equivalent is one-sixth of a ton.

Small engines are notoriously wasteful of steam. The average of 100 tests made by Mr. Bryan Donkin was 150 pounds of steam per h. p. hour, or about ten times that which should be required by a large compound condensing engine.

Under these conditions the comparison with electric driving, on the score of economy of power alone may be considered. Although higher efficiencies have been obtained, Mr. Geipel conservatively places the efficiencies in electric driving as follows:

Generators	.92 per cent.
Conductors	.98 per cent.
Motors	.85 per cent.
Total Efficiency	.76 per cent.

"That is, at full load, 76 per cent. of the power on the engine shaft is delivered at the shaft of the motor; deducting the friction of the engine, which will absorb, say 10 per cent., we then have 68 per cent. of the indicated horse power of the engine delivered at the motor shaft; at three-quarter

load it would be about 65 per cent. and at half load about 60 per cent. The efficiency of the electric machinery may vary slightly according to the design and the state of the load, but the above results may be taken as a fair average." It will not be far out to take two-thirds of the indicated power of the engine as delivered at the shaft of the motor.

Under the above assumptions Mr. Geipel proceeds to consider the reduction in the various losses when electric driving is substituted for shafting and belting, etc.

With the introduction of electric driving all heavy shafting is avoided, heavy tools having their own motors, while light tools are best arranged for group driving, a short length of shafting being driven by a motor and the power distributed to the tools by belting.

Thus the loss in shafting is avoided for heavy tools, and minimised for light ones. It must be remembered that when the motors are switched off there is no loss, while in the case of shafting the loss is a continuous one, a most important consideration for machinery working intermittently. In many instances the hours of actual machine driving are fewer than one-half the shop time, and with electrical driving there is a corresponding saving in transmission losses.

The loss in electrical conductors is much less than that in steam pipes, and with proper sizes of mains can be kept down to 2 per cent., besides which there is no loss except when the conductors are actually in use.

The steam economy is that due to the superior efficiency of large engines over small ones. As has already been shown, the consumption of steam in small engines, from tests by Mr. Donkin, average about 150 pounds per h. p. hour, while for a large, well constructed engine it may be as low as 16 pounds. Taking 68 per cent. delivered at the motor shaft, the steam charge for electric driving would be about 24 pounds per h. p. hour, so that there should be a saving of more than 100 pounds of steam per hour. Boiler evaporations range from 6 to 9 pounds of water per pound of coal, and Mr. Geipel assumes that a saving of 10 pounds per h. p. hour is a reasonable figure.

There are a number of minor economies resulting from the use of electric driving, but after all the greatest advantages are found in the increased output and in the greater convenience in arrangement of machinery.

Delays from slipping of belts, hot bearings, and local breakdowns are avoided, since any accident in one part of the works has no influence upon the rest of the machinery, while the better regulation and increased working speed possible, unite to produce the increased output which is invariably ascertained wherever electric driving is adopted. The improved disposition of machinery is a most important feature in economical working, since all tools can be placed with a view to the most advantageous operation rather than with regard to the location of line shafting. In one instance the introduction of electric driving enabled 4,000 men to do the work formerly requiring 6,000 men.

Mr. Geipel goes at length into the general arrangement of generators, motors and distribution, and concludes with a summing up of the advantages of electric driving, which in his opinion will effect a saving capable in most establishments of paying for the cost of installation of the electric plant in two to five years.

The various advantages are:

Absence of overhead shafting, which requires special construction of shops, and causes vibration, dust and dirt.

Absence of belts, dust arising therefrom, repairs necessary thereto, and shadows.

Clear head room for the use of electric cranes and hoists.

Better light and cleanliness.

Regularity of speed of machinery, and saving in wear and tear.

Placement of machinery to facilitate handling of work.

Easy application of motors for special tools, such as keyseating, cylinder boring, air compressing, etc.

Facility of running one or two machines without the rest, for working overtime.

Special suitability for working cranes and lifting apparatus.

Ease of extension.

Utility for electric lighting and other purposes.

General flexibility of the system.

Increased output.

REVIEW OF THE CONTINENTAL PRESS

The Metropol'tan Railway of Paris.

We have already given space in these columns to review of the constructive work upon the underground railway in Paris, called the "Metropolitan," and now we have an account of the experience which has been obtained in the operation of the portion already completed.

M. A. Dumas, in a recent issue of *Le Génie Civil,* describes at length the completed section, running from the Porte de Vincennes to the Porte Maillot, that is, directly across and beneath Paris. This section was opened to the public on July 19, 1900, and hence had been in service more than six months at the time of which M. Dumas writes, but the data upon which his account is based extend only to the close of December.

The general construction of the Metropolitan has been so often described that no attempt will be made to do so again at this time. It is sufficient to state that the portion now under consideration is about 6½ miles long, double-track underground, with eighteen stations situated at the busiest points of Paris.

The tractive power is electricity, on the third-rail system, the service consisting of trains of one motor car and three or four trailers, running at a headway of three minutes between trains, the entire run from the Porte de Vincennes to the Porte Maillot being made in 30 minutes including stops, this requiring a maximum speed of 18 to 20 miles an hour. The stops, now that the operators and the public have become accustomed to the road, are about half-a-minute in duration.

During the five months for which reports have been made public, the road has fully demonstrated its success, the total number of passengers having risen from 1,703,301 in August, 1900, to 3,447,241 in December, the receipts for the latter month being 587,000 francs. The number of passengers shows a steady rise from August to December, thus demonstrating that the travel was in no way due to the Exposition, but represents the natural movement of population. The total number of passengers carried for the period from July 19th to December 31, was 15,890,528, corresponding to the receipt of 2,694,563 francs; about 75 per cent. of the travel being second class. The price of tickets is 25 centimes for first-class and 15 centimes for second class, the only apparent difference between them being that the seats of the first class carriages are of leather, while those in the second-class are of wood. Tickets to go and return are also issued at 20 centimes, second class, these nearly equalling in number the total of first-class tickets for the period named.

These figures speak for themselves as to the popularity of the road, exceeding as they do the traffic of any other existing railway. The London Central, nearly of the same length, and started almost at the same time, carried 14,500,000 passengers up to December 31, 1900. Taking the figures obtained for the months of January and February, 1901, it is estimated that the traffic corresponded to a movement of more than four millions of passengers per kilometre per year, or about 2½ million per mile per year!

The carriages hold 30 seated persons and 20 standing, although many more often crowd in, despite the efforts of the guards, and it has already become a question as to how the capacity of the road is to be increased. Two methods are available, to diminish the distance between trains, and run them on a 2 minute headway instead of 3 minutes, or to increase the length of the trains. The reduced headway would increase the capacity only 50 per cent., and would greatly increase the difficulties of operation. The latter method permits a doubling of capacity as a maximum, trains of eight to nine cars being the greatest number which can be received at the platforms.

The present motor carriages, provided with two motors of 100 h. p. each, cannot haul more than three additional cars up the grades, and hence the longer trains would require two motor cars, preferably arranged to be under the control of a single operator. It is possible that the road will ultimately be operated entirely with motor cars, so that trains may be made up of any length as the traffic may demand at various hours.

The demand for tickets, and the necessity for keeping an accurate register of the number of passengers as a check upon the receipts, has led to the use of an ingenious ticket-printing machine.

The machine consists of a stand containing four little printers operated by an electric motor in the base. Three of the machines are arranged for printing the three kinds of tickets, the fourth being a reserve in case of accident. The mere pressing of a handle in front of each machine causes a ticket of that class to be printed and delivered to the operator, who is also the ticket seller, the tickets being printed only as sold and the machine automatically keeping count of the number printed, so that the difference between the readings at the beginning and end of the day gives the total sales immediately. The apparatus works very well, the ticket sellers being women.

M. Dumas gives some account of the construction and operation of the Hall automatic signal system, used on the road, and also describes the new Bercy power house recently completed for the supply of current to the Metropolitan.

The Poulsen Telephonograph.

SINCE the original invention of the phonograph by Edison there have been continual improvements, all tending toward the more satisfactory recording of the original vibrations, or towards the more accurate interchange of records. The most important of these improvements is that recently brought by a Danish electrician, M. Waldemar Poulsen, which attracted much attention at the Paris exposition, and formed the subject of an interesting paper by Mr. Jul. H. West, presented before the Electrotechnical Society of Berlin, and published in the *Elektrotechnische Zeitschrift*.

As is well-known, the phonograph makes its record by the indentations produced by a stylus attached to the under side of the diaphragm and bearing upon a surface of wax or soft metal; and this appears in the peculiar metallic tones of the reproduced sounds, the more delicate vibrations being much deadened. The sound is also reproduced directly upon the diaphragm of the instrument, and can only be transmitted to points within the reach of the hearing, aided by such trumpet or megaphone attachments as may be applicable.

In the telephonograph, however, the record is a magnetic, instead of a mechanical one, and it is this ingenious modification which has not only greatly improved the character of the record and its reproduction, but also greatly extended its range.

It is well known that steel is capable of permanent magnetisation, and that the degree of magnetization depends upon the magnetic field to which it is exposed. If, therefore a steel wire or ribbon has moved along its length an electro-magnet subjected to a varying current, the wire will be magnetized to a corresponding extent. Conversely, if an electro-magnet be moved along a wire which has been thus magnetized, it will reproduce a correspondingly varying current, and this current, passing through a telephone receiver, is converted into audible sounds.

In the telephonograph, a steel wire is wound in a helix upon a cylinder, with a clearance space between the coils, and a small electro-magnet is caused to traverse axially along the spiral in such a manner that its poles are close to the wire, although not in contact with it. The current from a battery passes around the poles of the magnet and also through the circuit of a telephone transmitter, and when the transmitter is spoken into, the variations in the current cause corresponding variations in magnetization to be produced in the wire. When the operation is reversed, the magnetized wire produces the vibrations in the diaphragm of the telephone receiver, and the message is reproduced with a far higher degree of accuracy than has ever been possible with any form of mechanically produced record. Such a record possesses many advantages, apart from its superior faithfulness to the original. In the first place there is practically no wear upon it, and experiments have shown that there is

no appreciable weakening after 10,000 repetitions of a record. As there is no contact between the wire and the magnet, there is no difficulty in regard to interchangeability, and the wires can readily be sent to any place and used on any machine. If it is desired to obliterate the record it is only necessary to pass the wire before the poles of an electro-magnet receiving a constant current, and the wire becomes a blank, ready to receive a new message.

Mechanical modifications of the principle will readily suggest themselves, and many varieties of the device have already been worked out. The apparatus is being carefully studied in the electrical laboratories of the makers, the firm of Mix & Genest, of Berlin, and some of these special forms were shown by Mr. West. Instead of using a cylinder, the wire or band may be wound from one spool to another, and any number of transmitters may be placed over the wire and be connected to telephones at various points. This arrangement has been adapted for the continuous transmission of intelligence to a number of subscribers, in a manner similar to the stock telegraph instruments. If the record is not to be preserved, the wire may be a short endless piece, led around two sheaves, passing first under the magnet connected with the transmitter, into which the information is spoken, and then under as many magnets as there are receivers to be served. On the return portion the wire passes between the poles of a magnet receiving a continuous current, the record thus being obliterated, and the endless piece made ready again for the transmitter.

Another application of the telephonograph is that of a telephone relay for long-distance lines, the record made at the end of one section being delivered into the transmitter of the next, and so on, indefinitely.

In view of the remarkable results which have thus far been obtained with the telephonograph, it appears as if many of the hopes produced by the original appearance of the phonograph may now be realized.

Practically perfect reproduction of articulate speech and musical sounds, over long distances, is assured. The indefinite multiplication of transmissions is accomplished, as well as absolute interchange of records without deterioration. The record is not susceptible to mechanical injury, rust or friction having no influence upon it, magnetic action being the only thing which changes it.

With all these advantages, it appears that the problem of the transformation of the phonograph from an interesting toy into a commercial apparatus for the recording and transmitting of intelligence is in a fair way to be solved, if that solution has not already been fully reached.

The Brittleness of Steel.

THE method of M. Fremont of studying the deformations of a metal under stress by scoring the test piece with cross lines and observing the change in the position of the lines when the piece is bent, has already been noticed in these pages. A practical application of the method is seen in the experimental study of the causes of brittleness in steel made by M. Fremont by the aid of his method, and published in a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale.*

It is well known that certain irons and steels may give results which appear very satisfactory in tension tests and yet fail altogether under bending. It was to examine the causes of these peculiarities that M. Fremont undertook his investigations.

Taking two specific cases, M. Fremont gives the data of several independent tension tests, showing the elastic limit, ultimate resistance, elongation, and reduction of cross-section; these data showing the specimens to be altogether satisfactory, and the curves shown on the recorder of the testing machinery were altogether similar in character. Specimens of the same two steels, when subjected to the bending test, however, showed a marked difference. One test piece, the one which showed the greater ductility under tension test, broke abruptly with only one-half the quantity of work shown by the other, while neither exhibited nearly so high resistance under statical bending test as a third specimen, of which the tensile test gave closely similar results to those of the first two.

Such results are even more marked under the drop test, as photographs of several specimens indicate, and altogether there appears to be every indication that some-

thing more than an ordinary tension test is necessary in order that the brittleness of a specimen may be determined.

It has been assumed by some investigators that the suddenness with which the load is applied is largely responsible for these differences, and within certain limits the effect of a blow can be clearly distinguished from an equivalent effort more slowly applied.

This, however, is by no means able to explain the facts, for the difference is often very slight, and M. Fremont shows specimens in which the difference between the effects of slow bending and a sudden drop cannot be distinguished.

In order to study just what really takes place the effects of a gradual bending test may be made visible. If the specimen be polished and properly illuminated, it is quite possible to see upon the surface of the metal the action of the internal forces, and M. Fremont gives a photograph showing very clearly the behaviour of the metal. The deformations may be separated into two elementary kinds, one being a depression and the other a swelling. The areas affected are practically elliptical in shape, and in a pliable specimen they partially neutralise each other, causing such a distribution of stresses that a bending without rupture is effected. In the case of a brittle steel the area of swelling is almost entirely absent, and the tension being concentrated in the lower edge of the specimen, rupture takes place suddenly. For intermediate qualities the results are correspondingly modified.

In order to explain the nature of these actions M. Fremont takes the cases of bars which have been provided with swellings corresponding to those produced by the compression of the normal test piece, and shows how the line of fracture is diverted by reason of the increased section at certain points, and then, from an examination of the behaviour of the specimen under compression, it can be seen to what extent these conditions obtain in actual practice.

It is in such studies that the applicability of the method of M. Fremont appears for regular testing. Briefly, his method consists in scoring the bar, always a small one, with parallel lines at right angles to its length, and consequently parallel to the directing of the applied force in a bending test. As the bar is bent the deformations taking place in it are indicated by the forms assumed by these lines, and it is plainly seen that instead of the theoretical distribution of compression and tension below and above a neutral axis, there is a neutral plane formed which is neither parallel to either face nor at a uniform distance between the faces.

According to numerous tests of this sort made by M. Fremont, it appears that the brittleness depends upon the location of the compression and tension deformations. If the deformation by compression is relatively slight the greater portion must be made by the tension, and if this tension is localised near the surface, rupture readily occurs.

The experiments show that a complete knowledge of the resistance of a metal cannot be obtained by either tension or compression tests alone. Both are necessary, while the bending test, in which both are united, enables a better knowledge to be obtained than is possible by any single test which can be applied.

The Development of Reinforced Concrete.

THE combination of iron or steel construction imbedded in concrete has now been in extensive use for about ten years, and during that time it has steadily gained in favor and application, the only unsuccessful instances having been those in which the principles were unknown or wrongly applied. The Paris exposition contained many examples of its use in building construction, and all over Europe the use of reinforced concrete, as it is generally called, is well known.

In recent issues of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* there is given a very complete review, by Herr F. von Emperger, of the development of steel and concrete construction, showing the increasing application of the system in recent years. An interesting feature in this development is seen in the extent to which it involves a return to masonry construction, formerly considered to be largely superseded by steel and iron framed structures.

Herr von Emperger begins by giving a number of illustrations of structures at the Paris exposition, showing the numerous

examples of the reinforced concrete construction there employed, and then passes to the various detailed methods, distinguished by the name of systems, and really differing from each other only in the arrangement of the metal reinforcement within the concrete.

The fundamental principle involved in all the systems is the combination of the two materials so that the metal may resist the tension at the same time that the concrete opposes the compression stresses, and it is important that the two materials should oppose their elastic resistances to the stresses proportionally, at least to such an extent that they may mutually reinforce each other under the applied loads.

Without going into the details of the various systems fully, the reader being referred for this to the original papers, it must be remembered that the fundamental advantage of the whole method of construction is economy. That is, economy in actual cost, and not necessarily economy of material, although in most instances they go together. In nearly every system the effort is seen to be the employment of as simple a metallic structure as possible. Either sheets of wire netting, or expanded metal, or some equally simple metallic skeleton, is extended between the supporting points, piers, beams, or the like, and the whole imbedded in a mass of concrete; or else beams of concrete containing imbedded rods or cables support flat floors of sheet concrete, also containing imbedded rods, the members being connected or separated by light pieces of hoop iron, or hooked rods, as in the Hennebique system. The Melan system, intended for arches only, uses a skeleton arch of some suitable structural shape, designed to suit the opening to be spanned, and forming a distinct structure within the concrete. In other cases twisted rods have been used to form the metallic portions of the structure, while piers and pillars have been made of old rails and similar material.

Herr von Emperger calls attention to the fact that the whole subject should be made a matter of intelligent engineering design, and that, instead of advocating this or that "system," the structure should be designed to conform to the conditions obtaining, and the tensile and compressive stresses distributed so as to be properly sustained by the respective materials.

An important feature is the quality of the materials composing the concrete, and it must not be assumed that any inferior grade of cement will serve for reinforced concrete construction. It is especially desirable that the concrete should be elastic, in order that it may permit the tensile stress to be sustained by the metallic portion before the concrete has become excessively strained or cracked. This point is necessarily involved in the proper disposition of the metal, and hence it is that the mere placing of some sort of a metallic skeleton in the midst of a mass of concrete is by no means a proper execution of the idea of reinforcement. In other words, the whole construction differs in no sense from other engineering work; it is "common sense applied to the use of materials"; and a high degree of common sense, and a good quality of materials are both as necessary in this as in other lines of work, if success is to be assured.

Water Gauge Glasses.

NOTWITHSTANDING the attempts which have been made to provide automatically for the maintenance of the proper water level in steam boilers, it has never been considered advisable to omit the provision of hand appliances for ascertaining the water level, and all boilers are equipped with gauge cocks and glass water gauges.

In the early days of steam engineering the low pressure used made it a simple matter to provide satisfactory water glasses, but with the high pressures now in general use this is not only more difficult, but the consequences of breakage are more serious. For these reasons the experiments which have been conducted in the Jena laboratories by Herren Schott and Herschkowitz, upon various kinds of tubes for gauge glasses, are of present interest and value. A detailed account of the investigations is published in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieur,* from which some abstracts are here made.

The tests to which the tubes for water gauges were subjected were: resistance to hot and cold pressure; freedom from injury by changes of temperature; and liability to corrosion by the water of the boiler. The

glasses tested during the present experiments included the regular French and English water-guages tubes, the Scotch glass tubes, and several varieties of glass made at the Jena works, including the standard Jena combination glass, the hard glass tubing used for ultimate organic analysis, and a new boro-silicate glass called "Durax," intended especially for water gauges.

The tubes tested were from 18 to 20 millimetres outside diameter and from 2 to 3.5 mm. thick. Under cold-water pressure, applied slowly by pump, the bursting pressures ranged between 170 atmospheres for the French glass to 333 atmospheres for the boro-silicate glass the Scotch tubes standing between and breaking at 249 atmospheres. These figures are all so much higher than any pressures employed in actual service that there is no need for comment in this respect.

An interesting feature in these tests was the fact that when the tubes were thoroughly annealed the resistance was not so high as when only partially annealed. The condition of the glass was ascertained by the use of the polariscope, which indicated the internal stresses. It appears that when the glass is not fully annealed there is a tension in the outer layers of the tube, corresponding to the initial stress in a hoop shrunk on a gun, and this assists in resisting the pressure from within.

An important portion of the tests was that relating to the resistance of the various tubes to the sudden application of cold spray on the outside when subject to hot pressure within. This is a condition which frequently occurs in actual service, when dripping water or spray is blown against the gauge glass. The apparatus was so arranged that the operator could observe the tube under test while protected by wire gauze and thick glass from the flying pieces. The pressure and temperature of the water in the glass were both under control and observation, and the investigator could direct the spray upon the outside of the tube at will. Under this test the Jena glass showed a distinct superiority, the French and Scotch tubes breaking at pressures of 6 to 8 atmospheres, while the Jena glass resisted pressures up to 15 to 25 atmospheres.

The question of the internal corrosion of gauge glasses is one of importance both because of the reduction in strength and also because of the obscuration of the visibility of the water level. Chemically pure, distilled water has a varying action upon glass according to the composition. The various tubes were tested by permitting condensed steam to trickle through them for a period of 50 hours, the tubes being weighed in a chemical balance before and after the operation to ascertain the loss in weight. This loss ranged from 8.84 milligrammes per square centimetre in the case of the Scotch tubes to 1.32 milligrammes in the case of the boro-silicate glass. In an 0.5 per cent. soda solution, and in a 0.1 per cent. soda lye solution the boro-silicate glass was much more actively attacked, and the Scotch glass was less acted upon. These facts should be kept in mind in the case of boilers which are not supplied with pure water as the use of certain precipitants as scale preventers may have something to do with the corrosion of gauge glasses in some cases.

In connection with the laboratory tests of gauge glasses it is interesting to observe the extent to which the conclusions are borne out. It was found that in tests of 600 to 700 hours' duration at pressures of 6 to 8 atmospheres, the loss in weight per square centimetre was about 6 milligrammes for the boro-silicate glass and about 9 millligrammes for ordinary glass, when no scale preventive was used in the boiler. When soda was used, the loss in weight was much greater, ranging from 15 to 25 milligrammes.

Some interesting details are given of the apparatus employed in the experiments by which reliable results were obtained without danger of injury to the investigators.

A New Type of Arc Lamp.

Ever since the time of Sir Humphrey Davy the electric arc has been produced in practice for lighting between carbon points, although arcs have naturally been produced experimentally and accidentally between many other substances. The objections to carbon are several, the principal one being the cost and trouble due to the frequent necessary renewals.

The invention of the Nernst incandescent lamp showed the high luminous power obtained when refractory metallic oxides are

rendered incandescent by the heat of the electric current, and this principle has now been extended to the arc lamp by Herr Ewald Rasch, whose experiments are described in a recent issue of the *Elektrotechnische Zeitschrift.*

Instead of using electrodes of carbon, which are rapidly consumed, Herr Rasch employs rods of refractory material, such as the oxides of magnesium, thorium, zirconium, etc. These substances, when cold, are non-conductors, but when warmed, as in the case of the Nernst lamp, they permit the current to flow, and when the arc is established, the heat maintains the conductivity. The preliminary heating is more simply accomplished than in the case of the Nernst lamp, an auxiliary arc being employed, the electrodes of this heating arc serving also as leads for the main arc.

Apart from the great advantage of employing permanent electrodes which require no renewal, the new lamp possesses a far higher efficiency than the carbon arc, the light emitted by the incandescent electrodes being much greater than with carbons. This is due to the high concentration of energy at the white incandescent ends of the electrodes, amounting to 30 to 40 watts per square millimetre, and more. The limit in this respect is only reached when the very high melting temperatures of the available materials are reached, such as the most refractory substances, say the metallic oxides, borides, silicides, carbides, etc.

The light emitted by this arc lamp differs materially from that of the Nernst and other incandescent lamps in that the spectrum is not continuous, but consists of various bands, according to the composition of the electrodes. Thus with electrodes of magnesia or zirconia a sun-white light is produced, the illumination being due not only to the incandescent rods themselves, but also to the minute particles electrolytically transferred from one terminal to the other. By the use of other materials, such as oxides of chromium or of nickel, lights of various colors may be produced, and brilliant effects obtained.

In the course of his experiments, Herr Rasch discovered that different materials possess varying availability for use as electrodes, and he classifies them according to their resistance and according to the temperature at which they permit the starting of the arc. Those electrodes which have a high resistance when cold also require to be heated to a high temperature before the arc can be started, and these he calls "hard" materials, while those with a lower resistance and a lower starting temperature, he calls "soft." Although the latter are more convenient as regards starting, they do not stand so high a temperature before fusion, when the arc is closed by the fused material. The hard electrodes give a better light and are more efficient, and hence well worth the additional heating which is required before starting.

Herr Rasch gives data and results of many of his experiments, showing the high efficiency of this new form of arc lamp, the results being plotted in curves. With electrodes 5 millimetres in diameter, and a current of 40 volts and 5 amperes, an average horizontal illumination of 900 Hefner candles was obtained.

The following comparative table, given by Herr Rasch, shows the superiority of the improved arc:

	Hefner Candles per Watt.
Incandescent Electric Lamp	0.29
Nernst Incandescent Lamp	0.66
Arc Lamp, Alternating Current	1.25
Arc Lamp, Continuous Current	2.00
Rasch Arc Lamp	3.00 to 4.00

This shows the new lamp to be practically double the maximum efficiency of the carbon arc lamp, apart from the great advantage of the permanency of the electrodes. The disadvantage of the necessity of preliminary heating must, of course, be considered, but as this may be accomplished in several simple ways it does not appear to be a serious difficulty.

Doubtless the new lamp will become the subject of extensive experiment, and should its practical advantages correspond to those obtained in the laboratory it will prove an important addition to the practice of electric lighting.

Although the precise details of the composition of the electrodes preferred by Herr Rasch are not made public, pending the completion of the patents, yet their general nature can be readily imagined, in view of the knowledge which has been obtained from the study of incandescent gas-mantles.

The Power Plant at the Paris Exposition.

An important contribution to the technology of power-plant construction and administration is found in an exhaustive paper upon the power installations at the Paris exposition, presented to the *Société des Ingénieurs Civils de France*, by M. Charles Bourdon, the chief engineer of the service, and published in the *Mémoires* of the society.

The paper contains many valuable details, covering the mechanical, electrical, and hydraulic plants, as well as the apparatus for handling materials, all of which came under the general division of the mechanical service of the exposition, and for these details reference must be had to the original paper, as only a general outline can be given here.

The general arrangement of the power house has already been described many times, and it is sufficient to remember that it extended entirely across the width of the Champ de Mars, with a tall chimney at each end, the boilers being arranged in double row, and the whole covering an area of 350 feet by 92 feet. There were 92 boilers in all, supplying about 500,000 pounds of steam per hour.

Owing to the arrangement of the steam engines, mainly in large units, in the portion of the buildings adjoining the boiler house, and the fact that nearly all the power was electrically distributed, it was possible to run all the mains in underground tunnels, giving access to the steam and water pipes at all times without disturbing the surface. M. Bourdon gives some interesting details as to connections, expansion joints, drainage, etc., in this connection which will doubtless be found applicable in permanent plants.

As already indicated, nearly all the power was electrically transmitted, but in the section of machine tools, and in the department of textile machinery, there was a partial demand for shafting, this being supplied by short lengths operated by separate motors, less than 5 per cent. of the total power being thus distributed. In fact, the absence of overhead shafting and belting formed one of the most characteristic differences between the exposition of 1900 and all its predecessors, and it thus clearly indicated to transformation which may be generally expected in industrial power plants in the immediate future.

The total power required for the service of the exposition was about 20,000 horse power, of which about 5,000 h. p. was for operating machinery and for other mechanical purposes, and the remaining 15,000 h. p. was for lighting. The plant also included an extensive hydraulic installation, the water being taken from the Seine by a special installation of Worthington pumping engines and delivered to the power plant, the supply being about 1,200 litres per second (about 42 cubic feet per second). The exposition was also authorised to take 300 litres per second, (about 10 cubic feet per second) from the city water supply.

An interesting portion of M. Bourdon's paper was that relating to the handling of exhibits, etc., the cranes and hoisting machinery being so arranged as to form exhibits themselves. Besides the cranes there were a number of elevators, operated by water under high pressure, this water afterwards being discharged into the cascades of the Chateau d'Eau, and falling gradually into the lower basin, where is united with the low pressure water supply which was delivered to the condensers of the low-pressure steam engines.

In connection with the boiler plant, the connections of the smoke flues from the various boilers to the tall chimneys, form an interesting study. The flues were so divided as to give the distant boilers as strong a draft as those closer to the chimneys, and also to prevent the draft of any battery of boilers from being affected by those of the other boilers. To enable any desired combination to be effected, several flues were arranged side by side, with connections to the main flues which could be regulated by metal covers, the cross section being thus kept fairly proportional to the volume of gases delivered. An inspection of the flues at the close of the exposition, after seven months of continuous operation, showed a deposit of about 20 inches of cinders at the base of the chimneys, this deposit extending only about 10 feet back into the main flues, the remainder of the passages being entirely clean, showing the uniform distribution of velocity.

The whole paper contains much of interest to the power plant engineer, and forms a valuable addition to the literature of steam engineering.

REVIEW OF THE AMERICAN PRESS

The River and Harbor of Chicago.

SINCE the completion of the canal connecting the Chicago river with the Mississippi the results of that important engineering work have been generally discussed from various points of view. At a recent meeting of the Western Society of Engineers the matter formed the subject of comment from a number of engineers, among whom may be named Messrs. L. E. Cooley, P. B. Weare, Isham Randolph, Captain J. G. Keith and others. From a publication of the discussion in the *Journal* of the Society the following abstract is made:

The canal was intended to reverse the current of the Chicago river and cause the flow to carry the sewage and other drainage into the Mississippi, instead of Lake Michigan, and thus prevent the pollution of the water supply drawn from the lake, as well as to replace the foul water of the river with an unobjectionable supply.

Permission was obtained from the United States government to make this diversion, under the condition that the current in the Chicago river should not exceed a mile and a quarter an hour, and that it be not used to the detriment of commerce. At the same time the law requires that on the present basis of 1,700,000 population, not less than 340,000 cubic feet of water per minute be carried out of the sanitary district, and that this volume shall be increased by 20,000 cubic feet for every 100,000 inhabitants. In addition to these points, it was provided that in case the general government should undertake the improvement of the Des Plaines and the Illinois rivers, the sanitary district should complete the channel with a capacity of not less than 600,000 cubic feet per minute.

This latter provision is intended to provide for a waterway through the state of Illinois, and is provided for under a contract between Chicago and the Illinois valley which cannot be set aside.

On the other hand it is found that the flow of even 225,000 cubic feet of water per minute through the Chicago river creates a current which makes it both difficult and dangerous to handle large boats in the river, and when, experimentally, 322,000 cubic feet per minute were put through it produced such a current that the docks were exposed to excessive wear, and navigation became so dangerous that insurance could not be obtained on vessels. At no time has the quantity of water been put through the river which the law requires and yet the detriment to commerce forbidden by the National government has been distinctly produced.

The natural result of this state of affairs has been that the heavy traffic of the river, notably the grain traffic, is being diverted to South Chicago, to Milwaukee, to Waukegan and other points. The importance of this matter, apart from the compliance with the legal conditions, is well stated by Mr. Weare when he stated that it was the lake and the river which had made the commerce of the city and not the railroads. The railroads came because of the canal, and river, and harbor, and if the trade was diverted to other points the position of Chicago would be lost and the city would become a mere way station.

Apart from these considerations, the desirability of the ship canal is undeniable. It is not only a duty to the population upon the Illinois river, but it is also a most desirable thing for Chicago. There are millions of dollars worth of trade in the great lakes which would be released by such a canal, and it is probable that it will be a reality in the next decade.

The injurious effects of the present current in the Chicago river were forcibly stated by Captain Keith. The government says that there shall not be a current of more than 1¼ miles an hour, while at the present time it is not less than 2 miles, and more frequently 3 miles per hour. Vessels have been damaged to the extent of $800 to

$1,200, and the costs for towage range from $200 to $400, as against $5 to $10, at competing ports.

The natural solution of the difficulty lies in the deepening and widening of the Chicago river, that is, the increase of the cross section in order to reduce the velocity. This again involves large expense both for construction works and for damages, and so the whole problem requires time and money, and while the time is passing the commerce is slipping away.

That the commerce of a great city like Chicago will be permitted to be ruined for causes which can be remedied by engineering skill cannot for a moment be conceded, but the whole subject is an interesting lesson of the manner in which the unexpected often happens.

Now that the drainage channel has been opened and the current in the river has been produced, it is evident to any one that it is just what might have been expected; but yet no one foresaw what is now such an obvious result. The river must be improved, the commerce of the city must be saved, and it will cost nearly as much as the whole cost of the channel to do it, apart from the time lost during the operation, but in the end the advantages will far outweigh the cost, both in time and in money.

The Relation of Steam and Electric Roads.

THE tendency to assume that there is some especial vested right in any branch of industry to those who have enjoyed sole possession of it for a long time, is very strong, and somehow there is a feeling of injury in the minds of such, when they perceive some invader into their domain. Doubtless just such a feeling exists in the minds of many railroad men when the question of the development of electric roads is mentioned, and it seems in many instances to be assumed that inter-urban electric roads are somehow poachers, so to speak, upon their own private business. The days when railways supplanted stage coach lines has been too long past for railroad men to realize that there was a day when they occupied the position of invaders, and so the old subject comes up again repeatedly, as if it were always a new one.

In a recent issue of the *Street Railway Journal* the question of the relation between electric and steam roads is discussed editorially in an interesting manner, and the importance of the subject renders it one appropriate for comment and review. The present situation is very clearly stated:

"The first office of the electric motor was to supplant the horse in the operation of purely street railways—mainly in cities—and uncomplicated by the keen demand for rapid transit, which has been the impelling force in the progress of electric railroading. So long as the art followed strictly in this narrow channel, one might broadly say that the electric railways had no particular relations with the steam railways, whose function—for the most part—was distinctly different, and which, save in the few elevated structures then in use, did not come into direct competition with tramway systems at all. As, however, the possibilities of electric traction began to become evident, the electric road passed very rapidly from being an improved tramway into a position differing radically both from tramways as they had been hitherto known, and from the ordinary means of suburban or interurban service. At the present time, not only has the electric road supplanted the horse, but it has supplemented the previous work of the steam suburban roads, and is already beginning to actively enter into competition with steam roads—not only in interurban service, but even in the heavier traffic which pertains to trunk lines."

Apart from the difference in the motive power, the electric tramway has a very strong hold upon popular favor because it carries him very near where he wishes to go, instead of delivering him at some arbitrary station from which he has more or less of a distance to go before his journey is completed. People do not, and in most cases cannot live on the line of a steam railway, and in the close vicinity or stations, and such locations are not desirable for residence, but the tramway, running along the street or highway, and stopping upon signal, is most convenient. The speed may not be so great, but it need not be, since the total time required for the journey from door to door may still be less. Apart from the time required in the actual journey there must be considered the time consumed in meeting certain trains, this almost invariably demanding a disturbance in the imme-

diate affairs of the day, lest the connection be missed. With the tramway the passenger boards the car when he is ready, and does so at some convenient point of departure, and is put down at or very near his destination, and this is exactly what he wants. With the steam railway, he must catch a train, purchase a ticket, and be delivered at a station, from which he finds his way homeward as best he may. The actual distance covered by the ride may be passed over more quickly by the steam road, and yet he may waste less time between actual terminals with the tramway. For long distances the steam railway is at present the superior; for short rides the electric tramway is far better; between the two there is a space where they overlap.

It is the handling of the traffic in this debatable distance of overlapping upon which the skill of management appears. The fundamental principle determining the critical point in the division of traffic is the total time consumed in taking the passenger from his house to his office, or between equivalent points. A very common mistake is the assumption that all the passengers must properly be brought to some general distributing point in a given city. This leads to a congestion of traffic and a limitation of usefulness, which might be largely avoided by arranging a number of termini, about equally distant from the dense centre of business and readily reached in a few minutes. The crowds would thus begin to be dispersed from the start, and good speed could be immediately established.

"The suburban steam roads get passengers who properly belong to the street railways, just in proportion to the amount of annoying congestion which the latter systems encounter. Anything which decreases this congestion means an added advantage over the only rival whom the street railway man now has to meet, and we believe that while improvements in motive power and increase of speed have done much to better the traffic conditions on large street railway systems, that there is still general room for improvement in the arrangement of schedules and of routes with reference to the distribution of the passengers."

The above considerations bear directly upon the present relations of steam and electric roads for suburban traffic, but it cannot be assumed that these relations are to remain permanent. The speed of electric cars will be increased just in proportion to the possibilities of the traffic, and the business side of the question will continue to depend upon the manner in which the service satisfies the wants of the passenger. If the electric road carries him more quickly, more cheaply, and as comfortably, between the points of his travel, he will undoubtedly use it to the abandonment of other systems. The distance over which the electric road can do this will doubtless continue to increase, and it is altogether possible that the limit will be the hours of daylight, and that through steam traffic may ultimately be relegated to long-distance journeys, involving night travel. Even here the tractive power may, and probably will be electricity, but that feature of the question is foreign to the present discussion. Certain it is, however, that suburban traffic belongs to the service which is most acceptable to the passengers, and past methods must give way to present ones, regardless of the opinions of those whose individual interests may be affected.

Power Distribution from Central Stations.

In a recent paper presented before the electrical section of the Franklin Institute, and published in the *Journal* of the institute, Mr. Charles F. Scott reviews the present state of the generation of electrical stations for power distribution in an interesting manner.

Leaving the question of the actual power generation in the steam portion of the plant for the present out of consideration, as well as the features involved in the determination of the size of units, location of sub-stations, and arrangement of distributing conductors, Mr. Scott devotes himself to the conversion of the mechanical into electrical energy, comparing the present practice with which obtained a few years ago.

"During the past few years central station engineers have been encountering new problems which have, in a measure, brought to life the old controversy between the direct current and the alternating current, although in a different form. The magnitude of electrical work, the areas which must now be covered, the economies which are necessary in the generation of current and its distribution, bring new requirements. The

wilderness of shafting, pulleys, belts and high-speed machines which did service some years ago has given place to stations with large direct-connected units; but even these are now becoming inadequate in stations for the generation of direct current for several reasons. The limited area over which current at low voltage can be distributed without undue cost for conductors makes it necessary to place the station at the centre of the district to be supplied, and if this area exceeds a few square miles, it is necessary to erect additional stations. The supply of current to a large area therefore comes from a number of stations, and the economies of a large generating plant are not secured. Moreover, as these central stations should be located near the centres of their respective areas, they will usually be found in districts where real estate is expensive and where there is not the advantage of cheap transportation of coal and ashes which might be secured if the location of the station were selected with respect to its own specific function of generating current cheaply, and not on account of the necessities of the distributing system."

It is these limiting conditions which have compelled the return to the alternating high-voltage system for current distribution, generally in connection with the use of the transformer and converter for the modification of the current before actual application. The alternator of to-day, however, is a very different machine from that of ten or twelve years ago. Direct connected machines are the rule.

"Belt and pulley have been discarded and the engine supplies the shaft and bearings. In many large machines the revolving armature has given place to a revolving field, which is constructed to have mechanical safety comparable with that of a fly-wheel, and in fact to perform the mechanical functions of a fly-wheel, thereby placing the fly-wheel exactly where it is required, without the strains which would otherwise come upon an intervening shaft. The stationary armature winding is laid in grooves or slots; it is not the hand winding of the olden time, but a succession of coils wound to exact dimensions on a lathe and insulated before being put in place, or else a succession of straight bars which can be shoved endwise into partially closed slots and joined at the ends by connectors of copper strap."

Mr. Scott goes into the question of parallel running at some length, showing the mechanical analogy to the engines geared to the same driving shaft, a certain degree of flexibility being provided by the assumption of flexible arms to the gear wheels. A similar analogy might be found in the connecting of more than one engine in connection with cable traction driving, including the use of the "jack-in-the-box" system of gearing to equalize the power.

The rotary converter comes in for a large share of attention, permitting, as it does, the economical conversion of high-pressure alternating currents into continuous currents of any desired pressure, suitable for use in street-railway or other motors. The use of induction motors is also considered, and their applicability to many purposes shown.

Regarding the central station of the future, Mr .Scott shows how the combinations of capital which tend to the concentration of the power and electric interests of a city into a single system; the development of electrical apparatus to meet the requirements of such a system; the prospect for cheapening of power; the development of the various means by which power may be utilized, are all factors which indicate that it is the central station of the future, from which is to come the energy upon which industrial life and social activity and advancing civilization depend.

Engineering in the Nineteenth Century.

In the course of a series of reviews covering the material progress of the nineteenth century and published in the *New York Sun*, there is included one on civil engineering written by Mr. Thomas Curtis Clarke, Past President of the American Society of Civil Engineers, and well known on both sides of the Atlantic as an engineer of wide experience and ability.

Mr. Clarke takes the position that the material prosperity of the last century was mainly due to three classes of men, the man of pure science, devoted to the discovery of the laws of nature; the inventor, eager to apply those laws to money-making purposes; and the engineer, making a scientific application of the laws of nature by

means of his knowledge of physical conditions.

Taking up the last department of the work, he divides the subject into statical and dynamical engineering, these being really more precise names for what are more commonly known as civil and mechanical engineering, the latter including electrical engineering, and all being included in the still broader title of industrial engineering, the production of articles useful to man.

Briefly running over the subdivisions selected by Mr. Clarke, we note structural enginering, railways, bridge building, foundations, hydraulics, power generation, metallurgy, and chemical technology. Of these but a few can be touched upon here, and that only to prepare for the general conclusions which follow. Of all these branches, only structural engineering, bridge building, and the necessary foundations had any material place before the beginning of the nineteenth century. Power generation, with the exception of water power, and that on a very limited scale, began with the utilization of coal, and Watt's invention, although dating from 1769, did not really begin to influence the world until the beginning of the last century; while railroading followed it nearly fifty years later.

With the development of railways came the corresponding advance in bridge-building with iron and steel, until we now have viaducts more than 300 feet high, and bridges with spans of 1,600 feet.

The older foundations were massive and secure, but slow and costly of construction. To-day we have the pneumatic process, sinking iron caissons, without disturbing the surrounding soil, and reaching rock through many feet of sand or earth.

In some forms hydraulic engineering is a very old branch of the art, but in others great advances have been made. Canals are now constructed of great size and with much rapidity, solely by reason of the use of improved machinery, while purification processes enable drinking water supplies to be had from sources otherwise entirely unsafe. One of the oldest sources of water supply for irrigation, the Nile, is soon to be regulated by the construction of the great dams at Assouan and Assiut, so that uncertainty will no longer exist as to the fertility of the seasons in Egypt.

But it is in mechanical engineering, properly so-called, that the greatest advances have been made. Not only in the generation and transmission of power, but also in its innumerable applications, the mechanical engineer has done far more in the nineteenth century than others had done in all the centuries which preceded it. The whole tendency of the work of the mechanical engineer has been to remove from man the necessity for physical effort, reserving for him the direction and control of forces generated for his use from the stored energy of nature. With this has come the greatly extended application of the principle of the duplication of pieces, so that articles of which the cost would be prohibitory if made singly, can be produced at a trifling cost by the thousand.

The winning of metals from the earth has advanced to such an extent that mines formerly abandoned have since well repaid the re-working, while iron and steel have become so vastly cheapened in cost as to be applicable for uses formerly out of the question. With these developments the art of steam navigation has developed to an extent which has produced floating power houses with the population of cities and the speed of railway trains.

In his conclusion Mr. Clarke pertinently asks why all this material development was delayed so late. He finds the answer to this question in the fact that in earlier ages the reign of law was not fully extended, securing to men the product of their labors, nor was there that union of scientists, inventors, and engineers, so necessary to the full development of all their work.

To-day all secrecy is disappearing, and all must work in the full light of day, while technical journalism, and the classification, indexing, and systematization of knowledge unite to enable every one to benefit by the work of all others.

"Combination, organization and scientific discovery, inventive ability, and engineering skill are now united.

"It may be said that we have gathered together all the inventions of the nineteenth century and called them works of engineering. This is not so. Engineering covers much more than invention. It includes all

works of sufficient size and intricacy to require men trained in the knowledge of the physical conditions which govern the mechanical application of the laws of nature. First comes scientific discovery, then invention, and lastly engineering. Faraday and Henry discovered the electrical laws which led to the invention of the dynamo, which was perfected by many minds. Engineering built such works as those at Niagara Falls to make it useful.

"An ignorant man may invent a safety pin, but he cannot build the Brooklyn Bridge.

The engineer-in-chief commands an army of experts, as without specialization little can be done. His is the comprehensive design, for which he alone is responsible. Such is the evolution of engineering, which began as a craft and has ended as a profession.

"In past times, civilization depended upon military engineering. Warriors at first used only the weapons of the hand. Then came military engineering, applied both to attack and defence, and culminating in the invention of gunpowder. The civilization of to-day depends greatly upon civil engineering, as we have tried to show. It has changed the face of the world and brought all men nearer together. It has improved the condition of man by sanitary appliances and lowering the cost of food. It has shown that through machinery the workman is better educated, and his wages are increased, while the profits of capital increase also. It has made representative government possible over vast areas of territory, and is democratizing the world.

"Thoughtful persons have asked, will this new civilization last, or will it go the way of its predecessors? Surely the answer is: All depends on good government, on the stability of law, order, and justice, protecting the rights of all classes. It will continue to grow with the growth of good government, prosper with its prosperity, and perish with its decay."

Locomotive Building in the United States.

In connection with the question of the development of American locomotive building, and the extent to which American locomotives have entered the markets of the world, some comments upon a statement, by Mr. John H. Converse, in a recent issue of the *Iron Age*, are appropriate.

Speaking as a member of the largest locomotive-building firm in the United States, Mr. Converse says that in his opinion there have been three reasons for the introduction of American locomotives into Europe and the colonies:

"First, the possibility of much earlier deliveries than any European works could make. Our large capacity and facilities have made it possible to fill a large order in a very short time. Second, to some extent the preference for American locomotives as to their type and size and details. And, third, the question of price. Owing to the design and character of American locomotives they can be and have been constructed at a less cost per unit of weight than the ordinary European locomotives, although the wages paid are considerably higher than the wages in European locomotive works. There are two reasons for that. In the first place, the character of American workmen, their disposition to be industrious and their intelligence in their work; and, second, the much larger use of machine tools and improved machinery in this country than abroad. The fact that we have a very large home market strengthens us for going abroad and seeking business."

The development of the American locomotive to meet the demands of the rapidly growing American service, both as to speed in express service and hauling capacity for freight trains, is emphasized by Mr. Converse. To-day there are trains running in the United States scheduled at speeds between 70 and 80 miles an hour. The introduction of heavier steel rails, and the strengthening of bridges and viaducts have both made possible heavier locomotives and cars.

"We have probably more than doubled the weight of locomotives in 25 or 30 years, and at the same time have made most important improvements in the quality of material, but have done it with an increase in the price of not more than 40 or 50 per cent. The changes in the material have been the adoption of steel for boilers instead of iron; of thicker boilers and stronger boilers, made in a much more expensive and elaborate way, so as to be capable of carrying a steam pressure of 200 pounds to the square inch,

whereas 30 or 40 years ago 100 pounds was the ordinary pressure. More parts are made of steel about the locomotive than formerly; tender frames are made of steel; the tanks are made of steel; the cabs are made of steel, where they were formerly of wood. All the wheels under a locomotive and tender are steel tired, where formerly both the tender and engine wheels were cast iron. This substitution has been made possible by great improvements in the production of steel. These changes are common to all locomotive works in America, but in Europe they have not been forced to make the changes which we have in this country. Their practice has been more firmly established there, and they have adhered to their original standards to a greater extent than we have. Our American railroad system was built up largely on borrowed money and had to be developed under conditions of the greatest economy; light rails, wooden bridges, cheap structures, cheap locomotives and cars had to be used in order to make it possible to stretch the railroads that we have stretched across our western territories; but with the growth of the country and the strengthening of these great railroad lines the roads have been rebuilt, and heavier rails and better bridges and better equipment have been substituted. The locomotive and car manufacturers simply reflect the development of the country, of its interests, and have adapted themselves to that development."

The introduction of American locomotives in some countries has been against very high tariffs, as for example in Russia, where the duty of four cents a pound is ample to protect Russian makers. For the Siberian railway, however, this did not enter, as the contracts provided for delivery on board steamer at a Russian port.

The principal difference between American and European locomotives is the use in America of the bar frame, contrasted with the plate frame. Outside cylinders are invariably used in America while in Europe inside cylinders and cranked axles are the rule, although many of the four-cylinder compound engines have both outside and inside cylinders. At the present time it appears as if the limit of weight for roadbed and bridges had been attained in the 100 ton locomotives, and that the maximum economy in hauling had been reached, but it is possible that even this present limit may be surpassed.

It is evident that in locomotive building, as in other things, it is the survival of the fittest which must be expected. The fittest, however, it not the same for all parts of the world. American conditions approach more nearly those of colonial and Russian service, than do those in England and central Europe, and hence it is not surprising that the American engines find their way to what may be termed their own locality. With the general unification of permanent way, including grades, curves, weight of rails, loading gauge, etc., there will probably be evolved an international type or types of locomotives, uniting all the best features of practice all over the world, and the local peculiarities will be merged in the general combination.

Deep Building Foundations.

THE modern tall building is also in many cases a deep building, for in but few instances is sufficiently solid foundation found near the surface. It is also in nearly every case desirable to provide space beneath ground for boilers, engines, dynamos, etc., and so cellars and sub-cellars are needed.

An interesting account of the construction of the deep foundation of a tall building in New York is found in a paper by Mr. T. Kennard Thomson in a recent issue of *Engineering News;* the structure under consideration being the new building for the Mutual Life Insurance Company. This description includes not only the sinking of the caissons to bed rock, but also the underpinning of the surrounding buildings, and as the site is in the midst of the tall building district, this latter became a much more serious problem than is usually the case.

Mr. Thomson's paper, which is very complete, is mainly a continuous narrative of the conduct of the work, including the manner in which the various obstacles were overcome, and for all details the original must be consulted. The principal features to be noted are the methods by which foundations carrying 20 to 70 tons per square foot of base were underpinned and permanently transferred to cylinders sunk for the purpose. Among these were the foundations of one wall of the Stokes Building, an

18 story office building, containing on the ground floor the vaults and safes of a safe-deposit company, the locks of which would be thrown out of gear by a very slight settlement.

The cylinders were first carried down through quicksand to hard pan, but when it was found that there was sand beneath this, it was considered best to go all the way down to the rock.

The work involved the use of many bold expedients for permitting the conduct of the foundation construction within a limited area, surrounded by high buildings in constant use, and the manner in which the new supports were placed under the existing walls, and the cellar for the new building excavated to a point 35 feet below the surrounding water level, all reflect great credit upon the engineers. As an instance of the bold application of engineering to building construction, this may well be considered an example of American ingenuity in overcoming difficulties, and the paper will doubtless be studied with much interest by constructing engineers in England as well as America.

Reinforced Concrete in America.

THE development of reinforced concrete in Europe has been discussed among the reviews of the Continental press, elsewhere in this issue, and as a fitting complement to the opinions of Herr von Emperger we may call attention to the symposium before the Boston Society of Civil Engineers, published in a recent issue of the *Journal of the Association of Engineering Societies.* Papers were contributed by a number of members, these relating mainly to the use of combinations of concrete and metal for floors and floor arches, as well as for fireproof construction.

In the United States, with some exceptions such as the Topeka bridge, and a few others, the use of reinforced concrete has mainly been as an auxiliary to metal construction, both for fireproofing, and as a convenient and satisfactory medium for the construction of walls, floors, and partitions. Its advantages for these purposes are now so generally admitted that it may soon become the standard method for floor construction in steel-frame buildings, taking the place of brick or tile arches. The question of rust appears to be no longer considered, and when the metal is properly imbedded in Portland cement concrete or plaster there need be no fear of weakening by rust, the metal being far better protected from dampness than when encased in tiles, brick, or other sheathing which permits the access of damp air. In this connection another advantage of concrete-metal construction for bridge and similar work appears, in that there is no need for the application of frequent coats of paint or other protection, since the structure, when completed is practically a monolith, and as permanent and enduring as if built of masonry.

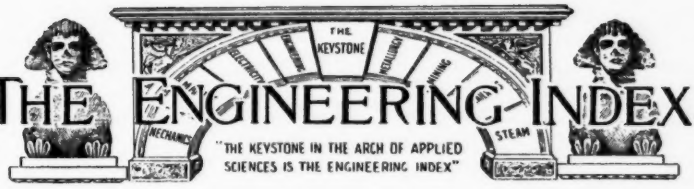
An allied application is the use of concrete sheathing for the protection of wooden piles from the attacks of the teredo navalis, a pipe being constructed about the pile after it has been driven to position. The cost is estimated as greater than that of coppering, and the durability of the combination has not yet been fully established. It has been stated that an electrolytic action may occur, due to the influence of the sea water, and this question can only be definitely settled by longer experience than has yet been possible.

Another use for reinforced construction, and one which has also been extensively employed in France, is for the building of water-conduits, and sewers. For such work expanded metal is especially applicable, and tests which have been made with experimental arches of this combination have been most satisfactory. The facility with which a conduit can be constructed in the trench is an especial advantage of the combination for such work, and it will doubtless have a wide application.

The various papers contain a great mass of detail and practical data concerning various systems, and it is remarkable to note how extensively the whole construction has developed with the few years which it has been before the public.

The opinion of such an authority as Mr. George S. Morison may well be quoted in this connection:

"I fully believe that we are now only at the beginning of concrete construction, and that, if the results which we hope for can be attained, with concrete structures with metal structures inside, the time will come when this will be the only method of building."



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Deçorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York
Trans. Inst. of Engrs. & Shipbuilders in Scotland. Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

CIVIL ENGINEERING

BRIDGES.

Arch.

Circular Arches Fixed at the Springings (Sur les Voûtes en Arc de Cercle Encastrées aux Naissances). M. Ribière. A mathematical analysis, deriving formulas based upon the elastic theory. 1000 w. Comptes Rendus—Feb. 11, 1901. No. 39916 D.

Bridge Building.

European and American Bridge Building Practice. T. C. Clarke. A comparison of methods showing the economy which has been effected by the extended use of machinery and standardisation, enabling American works to compete successfully for European and Colonial work. 3000 w. Engineering Magazine—April, 1901. No. 39965 B.

Caisson.

The Brooklyn Caisson for the Manhattan-Brooklyn Bridge. Illustrated description of a heavy timber pneumatic caisson 144 x 78 ft. in plan to carry one pier of a suspension bridge of 1,400 ft. clear span. 1900 w. Eng Rec—March 2, 1901. No. 39630.

Cantilever.

The Switchback Arch Bridge of the White Pass and Yukon Railway. Illustrated description of this interesting structure and its erection and tests. 1400 w. Eng News—March 28, 1901. No. 40050.

The "Switchback" Cantilever Bridge, White Pass & Yukon Ry. Illustration and description, stating the natural difficulties of the locality. 900 w. Ry & Engng Rev—March 16, 1901. No. 39895.

Design.

Aesthetics in Bridge Building. Remarks on the work of various nations, suggested by a paper read before the British Inst. of Civ. Engs. 1800 w. Arch, Lond—March 15, 1901. No. 40041 A.

The Aesthetic Treatment of Bridges. Review of a paper read by an engineer, Mr. Husband, before the British Inst. of Civ. Engs. 2000 w. Builder—March 15, 1901. No. 40042 A.

Drawbridge.

Floating a Drawbridge into Place. An illustrated account of the work of substituting a new and heavier drawbridge for an old one across the Hackensack River, on the Morris & Essex Div. of the D., L. & W. R. R. 2400 w. Ir Age—March 7, 1901. No. 39618.

Moving the Hackensack River Drawbridge. Illustrated description of the method of floating two large draw spans, one replacing the other. 2100 w. Eng. Rec.—March 9, 1901. No. 39696.

Two Drawbridges on the New York Central Railroad. An illustrated account of two steel drawbridges to be built, of interest because of the conditions to be met at the sites. 1500 w. R R Gaz—March 15, 1901. No. 39796.

Ferry.

The Overhead Ferry at Rouen. Reviews the usual methods of crossing channels, and describes the system of a car suspended from a high level bridge as used at Rouen, stating its advantages. Ill. 2000 w. Cons Repts, No. 996—March 28, 1901. No. 40062 D.

Foundations.

Some Odd Jobs of Foundation Work. W. A. Rogers. Describes a few problems in masonry and foundation work, of a perplexing nature, which have been solved during the last season by the Bridge and Building Department of one of the large railroads. 3300 w. R R Gaz—March 8, 1901. No. 39745.

Girders.

A Direct Method of Spacing Rivets and Finding the Position, Etc., of Stiffeners in Plate Girders. Continued discussion of paper by E. Schmidtt. 4500 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39583 E.

India.

Bridges of India. An illustration and brief description of the Jubilee (Hooghli) Bridge, East Indian Railway, is given in the present article. 700 w. Ind & East Engr—Feb., 1901. Serial. 1st part. No. 39813 D.

Kinzua Viaduct.

The Kinzua Viaduct of the Erie Railroad Company. Continued discussion of paper by C. R. Grimm. 6500 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39582 E.

Masonry.

Masonry. Report of the Com. of the Am. Ry. Engng. & Main. of Way Assn. Classifies the different kinds of masonry, discussing the materials, economic considerations, and designs. Also discussion. 15500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39887 D.

New York.

Brooklyn Tower Foundation, Third East River Bridge. An illustrated description of the caisson and cofferdam work and the masonry work. 2800 w. Eng News—March 7, 1901. No. 39673.

We supply copies of these articles. See introductory.

East River Bridge No. 3. Gives a map showing the location of the three bridges, with illustration and particulars concerning "No. 3," for which bids are now called. 900 w. R R Gaz—March 1, 1901. No. 39556.

Erection of Upper Parts of Towers of New East River Bridge, New York. Illustrated description of contractors' methods of constructing unusually lofty and heavy towers. 2000 w. Eng Rec—March 30, 1901. No. 40071.

The Fourth East River Bridge, New York. Description of cantilever structure 8,231 ft. long between Manhattan and Queens. 800 w. Eng Rec—March 16, 1901. No. 39820.

Reconstruction.

The Reconstruction of the Glasgow Bridge on the Chicago and Alton Railway. W. D. Taylor. Illustrated description of a railway bridge, 2,805 ft. long, over the Missouri River, with notes on special methods of erecting long spans and unusual details of steel work. 5000 w. Eng Rec—March 16, 1901. No. 39819.

Reinforced Concrete.

A Submerged Bridge. A discussion of the unique features of a concrete-steel bridge designed to be submerged 20 ft. at times in a swift current. 1000 w. Eng Rec—March 9, 1901. No. 39695.

The X Bridge at Mans, France. Illustrated description of a reinforced concrete structure having very light single columns with expansion rollers, on which rest plate-girder spans. 1100 w. Eng Rec—March 23, 1901. No. 39876.

See Civil Engineering, Construction.

Standard Plans.

Northern Pacific Standard Bridge Plans. Ralph Modjeski. An explanation of the new standards prepared by the writer, with critical discussion, and writer's conclusions. Also a diagram of weights, and plates. 6400 w. Jour W Soc of Engs—Feb., 1901. No. 39765 D.

Swing Bridge.

An English Floating Swing Bridge. Describes a swing span 112 ft. long, supported on a circular steel pontoon, made necessary on account of the rapid settlement of loaded ground due to the pumping of brine from below the surface. 1000 w. Eng Rec—March 23, 1901. No. 39879.

Sydney.

The Awards in the Sydney Bridge Competition. Brief description of leading designs for a very long bridge across Sydney Harbor, N. S. W., with diagram of cantilever design awarded first prize. 1200 w. Eng Rec—March 2, 1901. No. 39632.

Trestles.

Bridges and Trestles. Report of the Com. of the Am. Ry. Engng. & Main. of Way Assn. The subject was divided and assigned to seven sub-committees, whose various reports are submitted and discussed. Ill. 22000 w. Ry Age (Spe. No.)—March 15, 1901. No. 39889 D.

A New Subaqueous Viaduct. Fred W. Lepper. Illustrates and describes the engineering features of a proposed submarine viaduct. 1700 w. Eng News—March 28, 1901. No. 40056.

Viaducts.

The Gokteik Viaduct; Burmah Railways, Ltd., Burmah. Brief illustrated description of one of the most notable bridge structures erected by American bridge-builders in foreign countries. It is 2260 ft. long, and 320 ft. high, and required 4,852 tons of steel work for its construction. 1200 w. Eng News—Feb. 28, 1901. No. 39569.

Viaduct and Tunnel Construction on the North Bohemian Railway. (Die Viaduct und Tunnelbauten der Nordböhmischen Transversalbahn). H. Rosche. With details of the construction of large masonry viaducts and of the timbering of tunnels. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—March 1, 1901. No. 39928 B.

Viaduct at Jackson, Minn., C. M. & St. P. Ry. Illustrations and brief description of a steel trestle bridge with plate-girder deck spans, carrying a single track. 500 w. Ry & Engng Rev—March 2, 1901. No. 39626.

CONSTRUCTION.

Excavation.

Drilling and Blasting. Submerged Rock. A statement of the cost and methods of drilling and dredging 11,000 yds. of rock in 4 to 8 ft. of water. 1500 w. Eng Rec—March 9, 1901. No. 39697.

Sections 6 A and 6 B, New York Rapid Transit Railway. Illustrated description of the method of trenching in a crowded street without materially interfering with street railway traffic or wagons. 1800 w. Eng Rec—March 30, 1901. No. 40070.

Foundations.

The Foundations of the New Mutual Life Insurance Building, New York City. T. Kennard Thompson. Illustrated detailed description of one of the most notable tall building foundations ever constructed. 8500 w. Eng News—March 28, 1901. No. 40052.

Reinforced Concrete.

Recent Structures in Concrete and Iron (Neuere Bauweisen und Bauwerke aus Beton und Eisen). F. von Emperger. A fully illustrated description of the later combinations of iron and concrete construction with special reference to the

buildings at the Paris Exposition. Two articles. 7500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver. Feb. 15, 22, 1901. No. 39927 each B.

See Civil Engineering, Bridges.

Roads.

Oiled Road Construction in San Bernardino County, Cal. Describes a method of constructing a road from gravel and sand sprinkled with heavy oil and rolled much like macadam. 1200 w. Eng Rec—March 30, 1901. No. 40072.

Road Building and Other Public Works in Porto Rico Under the U. S. Military Administration. Illustrated article showing the extent and character of the work, abstracted from the reports of Capt. William Judson. 2000 w. Eng News—March 21, 1901. No. 39855.

The New Specifications for Broken Stone Roads in New Jersey. A review of the requirements adopted by the Association of State and County Road Engineers of New Jersey. 1200 w. Eng Rec—March 30, 1901. No. 40077.

Skeleton Construction.

Modern Construction at the Court Theatre, Vienna. Edwin O. Sachs. Drawings and discussion of features of constructional iron-work. 1700 w. Engng—Feb. 22, 1901. Serial. 1st part. No. 39603 A.

Strains.

Some Principles Common to All Building Materials. Frank Caws. A comparison of the strength and strains of building material with the human body. 6500 w. Jour Reg. Inst of Brit Archts—Feb. 9, 1901. No. 39661 C.

Tunneling.

Tunneling with a Roof Shield at East Boston. Illustrated description of the method of driving a double-track tunnel by means of advance headings on each side for the walls, with a roof shield run forward afterward on top of these walls. 900 w. Eng Rec—March 23, 1901. No. 39873.

Tunnel and Crib Construction in Chicago. Paul G. Brown. An illustrated review of the construction work, giving information concerning cost, methods, improvements, etc., in both lake and land tunnels. 7200 w. Jour W Soc of Engs—Feb., 1901. No. 39763 D.

CANALS, RIVERS AND HARBORS.

Dams.

Failure of Bulkhead at Dyer Dam, Danielson, Conn. Ernest H. Brownell. Describes the accident and explains its probable cause. Ill. 800 w. Eng News—March 28, 1901. No. 40054.

The Failure of Two Earth Dams at Providence, R. I. Ernest H. Brownell. An illustrated account of a recent disaster. 1300 w. Eng News—March 21, 1901. No. 39858.

Docks.

A New Dry-Dock at Baltimore. Illustrated description of a large timber dry-dock with concrete abutments constructed on a very unfavorable site. 1300 w. Eng Rec—March 16, 1901. No. 39822.

New C. M. & St. P. Ore Dock at Escanaba, Mich. Illustrated description of a recently completed dock of great capacity and modern design. 1500 w. Ry & Engng Rev—March 16, 1901. No. 39896.

New Dock and Harbor Works in the East of Scotland. An account of improvements at Grangemouth, Leith and Burntisland. Ill. 3000 w. Engr, Lond—March 8, 1901. No. 39807 A.

The Portsmouth Dry-Dock. Illustrated description of the method of excavating rock for a 750 x 130 ft. masonry dock, where the site was spanned by special truss conveyors delivering the spoil from the pit in either side of the site. 2800 w. Eng Rec—March 23, 1901. No. 39872.

Drainage Canal.

Design for a Controlling Works at the Chicago End of the Drainage Canal. Ossian Guthrie. Describes plan for the purpose of maintaining a uniform current for the relief and navigation of vessels. General discussion. 3800 w. Jour W Soc of Engs—Feb., 1901. No. 39764 D.

The Improvement of the Chicago River. Addresses at the annual dinner of the W. Soc. of Engs. by R. W. Hunt, L. E. Cooley, P. B. Weare, O. N. Carter, A. R. Reynolds, J. C. Braden, Wm. H. Chadwick, Isham Randolph, Wm. Boldenweck, and J. G. Keith. 11500 w. Jour W Soc of Engs—Feb., 1901. No. 39762 D.

Dredge.

A Large Single-Rope Dipper Dredge. Illustrates and describes a large dipper dredge recently put in service at Chicago, for river and harbor improvements. 1400 w. Eng News—Feb. 28, 1901. No. 39574.

Groynes.

Beard's Contour System of Groynes. Brief illustrated description of this system which is designed to take advantage of the action of the sea to build up a beach that will form a permanent natural protection. 1200 w. Engng—Feb. 22, 1901. No. 39608 A.

Isthmian Canal.

The Isthmian Canal from a Military Point of View. Col. Peter C. Hains. Extract from an address before the Am. Acad. of Political and Social Science. Considers a neutral canal, with a large area of neutral waters at each terminus a more useful canal to the United States

than one controlled by military power. 700 w. Eng News—Feb. 28, 1901. No. 39573.

Lighthouse.

Metal Casing for a Light House Tower at Grande Pointe au Sable. Illustrated description of the sheet steel casing built about a brick shaft beginning to deteriorate. 1100 w. Eng Rec—March 2, 1901. No. 39634.

London.

The Port of London. W. H. Wheeler. Discusses the unsatisfactory conditions of this port and the causes. 4000 w. Engr, Lond—March 1, 1901. No. 39730 A.

Naples.

The Harbor of Naples (Le Port de Naples). C. de Cordemoy. With plan of the harbor and elevations and sections of the moles. 1800 w. Revue Technique—Feb. 25, 1901. No. 39908 D.

New York Canals.

Canals from the Lakes to New York. Continued discussion of papers by Messrs. Joseph Mayer and George Y. Wisner. 14000 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39581 E.

Surveys for a Barge Canal Across the State of New York. Abstract of the report of the survey presented to the Governor by the State Engineer, stating the important features. Also editorial discussion with extracts from the Governor's message. 4500 w. Eng News—March 21, 1901. No. 39856.

The Latest Report on the Improvement of the Erie Canal. A review of the recommendations of the State Engineer for a 1,000-ton barge canal, and of the Governor for a smaller waterway. 2200 w. Eng Rec—March 23, 1901. No. 39871.

Panama.

Recent Claims for the Panama Canal. A discussion of the influence of earthquakes, trade winds and curvature on the selection of a route across the isthmus. 1500 w. Eng Rec—March 30, 1901. No. 40068.

The Panama Canals. Editorial review of paper by J. T. Ford, read before the Inst. of Civ. Engs. (England), discussing the engineering lessons to be learned from the conditon of the Panama Canal works since their abandonment. 1300 w. Eng Rec—March 2, 1901. No. 39629.

Sault Ste. Marie.

Clergue's Great Enterprises. Review of what Francis H. Clergue and his associates have done at Sault Ste. Marie, and what they propose to do. 4000 w. Marine Rev—March 7, 1901. No. 39753.

MATERIALS.

Artificial Stone.

The Industry of Sandstone Bricks (L'Industrie de la Brique de Grès). H. de Graffigny. A review of the various processes in practical use for making artificial stone bricks of lime and sand. 2500 w. Revue Technique—Feb. 25, 1901. No. 39909 D.

Asphalt.

Alcatraz Asphalt. Notes concerning the elaborate methods for dissolving in naphtha and piping 30 miles asphalt obtained by boiling asphaltic sand. 600 w. Eng Rec—March 23, 1901. No. 39874.

The Asphalt Deposits of Venezuela. From the *N. Y. Times*. Map and description. 1000 w. Eng & Min Jour—March 9, 1901. No. 39752.

The Pitch Lake and the Asphalt Industry of Trinidad. An illustrated description of the deposit and method of excavating, transporting, etc. 1800 w. Sci Am—March 16, 1901. No. 39775.

Cement.

American Slag Cements. Abstract of paper by W. K. Hatt, giving results of tests of cement made by grinding a mixture of slag and lime. 1600 w. Eng Rec—March 2, 1901. No. 39631.

Cement Kilns.

A British Opinion of Rotary Current Kilns. An abstract of a paper by W. H. Stanger and B. Blount before the Inst. of Civ. Engs., approving American rotary kiln practice. 1000 w. Eng Rec—March 16, 1901. No. 39823.

Concrete.

Concrete Mixing and Depositing Machine. Illustrates and describes the concrete train for making and depositing concrete for retaining walls used on the Chicago & Western Indiana R. R. 1200 w. Eng News—Feb. 28, 1901. No. 39571.

Fireproofing.

A Discussion of Recent Developments in the Fire Proofing of Wood. Joseph L. Ferrell. Illustrated description of the methods, and tools used and a statement of the efficacy of the treatment. 4000 w. Jour Fr Inst—March, 1901. No. 39640 D.

Timber.

The Strength of Timber. Discusses tests made and quotes from records of investigations by the U. S. A. Dept. of Agriculture. 2700 w. Builder—March 2, 1901. No. 39718 A.

MEASUREMENT.

Spirit Leveling.

The Theory and Practice of Precise Spirit Leveling. David A. Molitor. Continued discussion of this paper. 9500 w. Pro Am Soc of Civ Engs—March, 1901. No. 40081 E.

Surveying.

A Simple and Convenient Instrument for Mine Surveys. Frank Robbins. Read

before the Canadian Min. Inst. Illustrated description. 2500 w. Can Min Rev—Feb. 28, 1901. No. 39666 B.

The Adjustment of a Transit Survey as Compared with That of a Compass Survey. George W. Tuttle. Discussion of the paper by Charles L. Crandall. 2000 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39584 E.

The Adjustment of a Transit Survey as Compared with That of a Compass Survey. Continued discussion of a paper by C. L. Crandall. 2400 w. Pro Am Soc of Civ Engs—March, 1901. No. 40082 E.

MUNICIPAL.

Ancient Sanitation.

Sanitary Provisions in the Roman Colony at Lincoln, England. Abstract of a paper by Dr. William O'Neill, on the water and sewerage systems, crematory, and private baths. 1500 w. Eng Rec—March 23, 1901. No. 39880.

Chattanooga, Tenn.

Municipal Improvements at Chattanooga, Tenn. An account of improvements in the sewerage system, pavements, garbage disposal, etc. Ill. 2600 w. Eng News—March 7, 1901. No. 39671.

Garbage.

Garbage as Fuel for Steam Production. W. L. Hedenberg. States the success gained in England and urges a study of the subject in the United States as a matter of economy. 1000 w. Munic Engng—March, 1901. No. 39647 C.

Pavements.

Repairing Asphalt Pavements in Chattanooga. Robert Hooke. Describes methods used and gives illustration of a portable heater designed by the writer. 1700 w. Munic Engng—March, 1901. No. 39645 C.

Some Facts Relating to the Asphalt Paving Industry. P. W. Henry. Condensed from an address before the students of Rensselaer Polytechnic Inst. Reviews the development of this industry, especially in the United States, describing the foundation and the mixture, and the Pitch Lake of Trinidad and other deposits. 6400 w. Eng News—March 14, 1901. No. 39791.

Sewage Disposal.

A New Form of Septic Tank for Holland, Michigan. Messrs. Alvord & Shields. Illustrated description of a tank arranged to permit large variations in its capacity to suit the character of sewage to be treated. 1700 w. Eng Rec—March 16, 1901. No. 39821.

Recent Progress in Sewage Purification in England. Gilbert J. Fowler. Information concerning results of recent practice in England, and experimental work, with conclusions reached. 5000 w. Dom Engng—March 15, 1901. No. 37-846 C.

Sewage Disposal and Water Purification. John N. McClintock. Read before the Am. Soc. of Munic. Imp. Describes a septic tank system for sewage disposal, and explains its working, applying also the same principle to the purification of water. 4800 w. Dom Engng—March 15, 1901. No. 39847 C.

Sewage Disposal. A paper before the Indiana Engng Soc., by F. A. Barbour, on the utility of bacteriolytic processes of treatment and the degree of purification which it is advisable to strive for. 2900 w. Eng Rec—March 30, 1901. No. 40075.

The Connecticut Sewerage Commission on Methods of Sewage Disposal. A statement by a State Board on the merits and disadvantages of sewage disposal by chemical treatment, filtration, septic treatment, and biological filtration. 2500 w. Eng Rec—March 23, 1901. No. 39875.

Sewerage.

An Early Example of Combined Septic Treatment and Filtration of Sewage. Describes small installations in Italy made prior to 1890. 1200 w. Eng Rec—March 30, 1901. No. 40069.

Annual Reports of the State Sewerage Commissions of Connecticut and New Jersey. Describes the work of the commission in each State, and comments on the reports. 2700 w. Eng News—March 28, 1901. No. 40053.

Sewerage Systems of Industrial Works. An account of methods of construction found desirable in German works where the industrial wastes cause rapid deterioration of ordinary construction. 3800 w. Eng Rec—March 23, 1901. No. 39-878.

The Shelby, Ohio, Sewerage System. J. B. Weddell. Abstract of paper read before the Ohio Soc. of Surv. and Civ. Engs. Illustrated description of sewerage and sewage disposal works for 5,000 people. The sewage is received in tanks and passed through intermittent filters. 600 w. Eng Rec—March 9, 1901. No. 39698.

Streets.

The State of London Streets. Thomas Blashill. Read at meeting of the Sanitary Inst. Compares the streets of London with Continental cities and towns to their detriment, and discusses some details where improvements are needed. 2800 w. Builder—Feb. 23, 1901. No. 39592 A.

WATER SUPPLY.

Compressed Air Storage.

A Small Water-Works Plant at Trotwood, O., With Storage Under Compressed Air. Benjamin H. Flynn. Describes a small plant, in which the water is stored in a tank under an air pressure

of 40 to 80 pounds. 600 w. Eng News—March 21, 1901. No. 39859.

Electrolysis.

Cause and Effect of Electrolytic Action Upon Underground Piping Systems. A. A. Kundson. Considers the cause of deflection of currents from well-bonded tracks to water mains; acute points of deflection; effect of joint resistance on water mains; effect upon water mains in a positive district. Ill. and discussion. 11200 w. Jour N. E. Water Wks Assn—March, 1901. No. 39638 F.

Electrical Current. F. A. W. Davis. A statement of the destructive action upon gas and water pipes, with illustrations. Also report of decisions of the U. S. courts in regard to difficulties arising from this cause. 3000 w. Jour N. E. Water Works Assn—March, 1901. No. 39636 F.

Factory Supply.

Water Supply Plant at the New Kensington Works of the Pittsburg Reduction Co. Edwin S. Fickes. Illustrated description of the plant and the difficulty experienced in sinking the suction well. 1100 w. Eng News—March 21, 1901. No. 39857.

Filters.

Covering Water Filters. A discussion, by Allen Hazen, of the condition under which it is advisable to cover sand filters. 4300 w. Eng Rec—March 23, 1901. No. 39877.

The Construction of Gravity Sand Filters at Nyack, N. Y. Discussion of paper by G. N. Houston. 3000 w. Pro Am Soc of Civ Engs—March, 1901. No. 40083 E.

The Sand Filters at Whitestown, N. Y. William G. Stone. Illustrated description of open sand filters with rather unusual arrangements of pipe for outlets and inlets. 1200 w. Eng Rec—March 30, 1901. No. 40074.

Filtration.

Filtration of Water for Public Use. Continued informal discussion on the above subject. 1600 w. Pro Am Soc of Civ Engs—March, 1901. No. 40084 E.

Gauge.

An Inexpensive Gauge for Use with the Venturi Meter. Charles P. Paulding. Explains briefly the theory of the Venturi tube, and gives illustrated description of the gauge devised by Henry Metcalfe for use with this water meter. 1200 w. Eng News—Feb. 28, 1901. No. 39570.

Ground Water.

Subterranean Waters. Charles Morris. Considers the conditions under which interior water exists, the service rendered by it, etc. General discussion follows. 4000 w. Jour Fr Inst—March, 1901. No. 39641 D.

Hotel Supply.

Plumbing in the Manhattan Hotel, New York. Illustrated description of the water supply system of a large New York hotel having a filter plant of 600 gallons' capacity per minute. 2000 w. Eng Rec—March 16, 1901. Serial. 1st part. No. 39827.

Irrigation.

An Unwatered Empire. Gen. Nelson A. Miles. On the importance of irrigation and the arid regions that could by this means be made productive. 1200 w. W Min Wld—Feb. 23, 1901. No. 39538.

Pumping Engine.

See Mechanical Engineering, Hydraulics.

Purification.

Experts' Report on Water Purification at Washington, D. C. Report of Messrs. Rudolph Hering, George W. Fuller, and Allen Hazen, to the Chairman of the U. S. Senate Committee. 2000 w. Eng News—Feb. 28, 1901. No. 39575.

Self-Purification of Polluted Water-Courses. Extracts from a report by Dr. Arthur R. Reynolds on experiments made on the waterway between Chicago and St. Louis. 4000 w. Eng Rec—March 16, 1901. No. 39824.

The Bacterial Self-Purification of Streams. Concerning the investigations conducted by Edwin Oakes Jordan, Ph. D., on the waters of the Illinois River and its tributaries, including observations at various points as far as the Mississippi. 1800 w. Sci Am Sup—March 2, 1901. No. 39544.

The Pollution and Self-Purification of Streams (Die Verunreinigung und Selbstreinigung der Flüsse). H. C. Nussbaum. An examination of the bacteriological conditions of rivers, with regard to their use for water supply; with data from various German rivers. 3000 w. Gesundheits-Ingenieur—March 15, 1901. No. 39940 B.

Water Mains.

Removal of Some Submerged Water Mains, at Chelsea, Mass. Caleb Mills Saville. Interesting description of the condition of a main laid in 1850, and of a siphon carrying water over the Mystic River. 2700 w. Eng News—Feb. 28, 1901. No. 39568.

Water Works.

A Model System of Water-Works. F. O. Jones. Illustrated description of a system suited for both domestic purposes and fire protection. 1600 w. Sci Am Sup—March 2, 1901. No. 39545.

The Pratt City Water-Works. Illustrated description of a small plant using an air lift for raising water from deep wells. 900 w. Eng Rec—March 30, 1901. No. 40073.

ELECTRICAL ENGINEERING

COMMUNICATION.

Arc.

The Speaking Electric Arc (Der Sprechende Elektrische Flammenbogen). E. Ruhmer. An examination of the vibrating electric arc as a receiver and transmitter; and its application to wireless telegraphy. 2000 w. Elektrotech Zeitschr —Feb. 28, 1901. No. 39951 B.

Cables.

High Tension Cables. E. Kilburn Scott. Discusses various kinds of insulation favoring the Brooks semi-solid system. 2500 w. Elec Rev, Lond—March 8, 1901. No. 39802 A.

Exchange.

A Notable Independent Telephone Exchange. George L. Burlingame. Illustrated description of the lamp signal branch exchange at East Cleveland, Ohio, of the Cuyahoga Telephone Company. 1900 w. Am Elect'n—March, 1901. No. 39682.

Long Distance.

The Long Distance Telegraph and Telephone Systems of Pupin, Thompson and Reed. E. F. Roeber. Considers these three methods, developing a mathematical theory of the Thompson system and the Reed system, following the analytical method used by Dr. Pupin. 2700 w. Elec Wld & Engr—March 16, 1901. Serial. 1st part. No. 39840.

Transatlantic Communication by Means of the Telephone. M. I. Pupin. An exposition by Dr. Pupin, of the improvements made by him in long-distance telephone lines, by which transatlantic telephony may become practicable. 4000 w. Engineering Magazine—April, 1901. No. 39969 B.

Wave Transmission Over Non-Uniform Cables and Long Distance Air Lines. M. I. Pupin. Discussion of the above named paper. 2700 w. Trans Am Inst of Elec Engs—Feb., 1901. No. 40002 D.

Microphone.

Berliner Microphone Patent Declared Invalid. States the claims of the patent and the substance of the recent decision at Boston by Judge Brown who decides that Berliner was antedated by both Bell and Edison. 2500 w. Elec Wld & Engr—March 2, 1901. No. 39623.

Berliner Telephone Patent Declared Invalid. Full text of decision as handed down at Boston, deciding the invention antedated by both Bell and Edison. 5000 w. Elec Rev, N. Y.—March 2, 1901. No. 39651.

Comment on the Berliner Patent Decision. A view of the telephone situation in the United States, giving interviews and opinions of prominent men, and the Berliner patent in full. Also editorial. 5500 w. Elec Rev, N. Y.—March 9, 1901. No. 39717.

Multiplex.

Multiplex Wireless Telegraphy with Tuned Apparatus. Discusses Prof. Slaby's experiments for using wireless telegraphy without interference of messages, and the solution of the problem; also the work of others in this field. 2300 w. Elec Rev, Lond—March 15, 1901. Serial. 1st part. No. 40022 A.

Space Telegraphy.

Present Condition of Wireless Telegraphy. Data received from Emile Guarini regarding wireless telegraphy; the system at present most popular; various systems in different lands; describing that employed by Mr. Guarini. 3300 w. U. S. Cons Repts, No. 977—March 6, 1901. No. 39772 D.

The Slaby Systems of Wave-Selective Wireless Duplex Telegraphy. Illustrates and describes this system which has proved successful, and explains the method of transmitting and receiving messages without interference with other stations. Also editorial. 2000 w. Sci Am—March 9, 1901. No. 39686.

Wireless Telegraphy. Dr. F. Braun. Substance of lectures delivered before the Strassburg scientific societies on experiments in this field. 1800 w. Elect'n, Lond —March 15, 1901. No. 40046 A.

Telegraphs.

The Burry Page-Printing Telegraph. Illustrated description of this very successful invention. A large number of the machines may be operated at the same time by a single sender at a central station. 2300 w. Sci Am—March 23, 1901. No. 39851.

Telephony.

The Arrangement of Several Telephones Upon the Same Circuit (Montage de Plusieurs Postes Téléphoniques sur un Meme Circuit). Em. Piérard. A comparison of the arrangements in series and in derivation. 1200 w. Electricien—March 2, 1901. No. 39934 B.

The Invention of the Telephone. George S. Davis. Gives the claims of William A. Skenkle to the invention. Also editorial. Ill. 3800 w. Elec Wld & Engr—March 23, 1901. No. 40010.

Telephonograph.

The Poulsen Telephonograph (Ueber den Telephonographen von Poulsen). Jul. H. West. A paper read before the Electrotechnical Society, illustrating and de-

scribing very fully the adaptation of the phonograph for recording telephonic communications. 4000 w. Elektrotech Zeitschr—Feb. 21, 1901. No. 39947 B.

Transmitter.

A Practical Transmitter Using the Line Wave for Cable Telegraphy; and Measurements with Alternating Currents Upon an Atlantic Cable. Albert C. Crehore and George O. Squier. Discussion of the above paper. 6800 w. Trans Am Inst of Elec Engs—Feb., 1901. No. 40001 D.

DISTRIBUTION.

Cables.

Insulation on Cables. Mervyn O'Gorman. Abstract of a paper read before the Inst. of Elec. Engs. (Eng.), with editorial. On the manufacture of cables, and their design. 7000 w. Elect'n, Lond—March 15, 1901. No. 40047 A.

Current Densities.

The Economical Current Density for Small Conductors. James Whitcher. The present article is an argument favoring the use of Lord Kelvin's law in the design of electric wiring systems, to be followed by a discussion of its practical application. 1500 w. Elec Rev, Lond—March 1, 1901. Serial. 1st part. No. 39693 A.

Switchboards.

The Niagara Falls Power Company's Switchboards. Arthur B. Weeks. Illustrated description of recent developments and improvements; feeder stands, emergency switches, etc. 1300 w. Elec Rev, N. Y.—March 2, 1901. No. 39650.

ELECTRO-CHEMISTRY.

Accumulators.

Acids for Filling Electric Accumulators. Rudolf Heinz. Translated from *Centralbatt für Accumulatoren und Elementenkunde.* On the importance of purity to prevent damage to the accumulators. 800 w. Elec, N. Y.—March 6, 1901. No. 40059.

Analysis.

Estimation of Metals by Electrolysis. Charles Nathan. Remarks on the history of electrolysis as applied to analysis, with description of apparatus and general conditions. 2000 w. Elec Chem & Met—Feb., 1901. Serial. 1st part. No. 39565 A.

Cells.

The Solvay Electrolytic Alkali Cell. John B. C. Kershaw. Illustrated description of the principles and design of this new form of cell. 600 w. Elect'n, Lond—March 15, 1901. No. 40048 A.

Electrochemistry.

Electrochemistry and Electrometallurgy. Francis B. Crocker. Part first presents the theory, discussing the principles and the general relation between the electrical quantities. 7000 w. Sch of Mines Quar—Jan., 1901. Serial. 1st part. No. 39768 D.

Electro-Metallurgy.

Electro-Metallurgy in Europe in 1900. John B. C. Kershaw. Reports concerning aluminum, copper, nickel, silver and gold, and zinc. 1800 w. Elec, N. Y.—March 20, 1901. No. 40060.

ELECTRO-PHYSICS.

Batteries.

Calculating a Battery for a Given Output. Dr. K. Norden. On the calculation of storage batteries for given discharge rates, referring to two papers recently published in German journals, and giving a method devised by the writer. 900 w. Elec Wld & Engr—March 9, 1901. No. 39748.

Clark Cell.

The Various Determinations of the E. M. F. of the Clark Cell. Henry S. Carhart. Reviews the various determinations made of the E. M. F. of the Clark Cell. 2000 w. Elec-Chem & Met—Feb., 1901. No. 39564 A.

Dielectrics.

Contributions to the Study of Dielectric Bodies (Neuere Beiträge zur Naturgeschichte Dielektrischer Körper). Dr. Moritz von Hoor. An elaborate study of condensers, using various materials as dielectrics. Many tables and diagrams are given. Three articles, 10000 w. Elektrotech Zeitschr—Feb. 21, 28, March 7, 1901. No. 39944 each B.

Expansion.

Magnetic Expansion of Iron and Nickel. Philip E. Shaw and S. C. Laws. Briefly reviews past research in this field, where the optical lever method has been adopted for measuring, and shows in this paper that these changes can be observed by an entirely different method, which has the advantages of greater delicacy and much greater range. Ill. 2200 w. Elect'n, Lond—Feb. 22, 1901. Serial. 1st part. No. 39595 A.

Oscillator.

A New Oscillator for Stationary Electrical Waves. Dr. Bernouilli. Brief illustrated description of the Blondlot-Cooldge oscillator, with remarks on the researches of Hertz and Lecher. 1000 w. Elect'n, Lond—March 8, 1901. No. 39801 A.

Theory.

The Propagation of Electrical Energy (Ueber die Fortpflanzung der Elektrischen Kraft). Dr. Gustav Platner. An examination of the various theories from the

electrolytic point of view; discussing the relation between electrical and chemical energy. 5000 w. Electrochemische Zeitschr—Feb., 1901. No. 39952 H.

GENERATING STATIONS.

Armature Windings.

A Comparison of Dynamos with Surface-Wound and Slot-Wound Armatures. P. M. Heldt. Arguing that for small machines of given weight and angular velocity, at least 50 per cent. more output can be obtained if the armature is slot wound than if it is surface wound. 1000 w. Am Elect'n—March, 1901. No. 39683.

Dynamos.

Large Generators (Grosse Generatoren). A. Rothert. A study of dynamo design, comparing the writer's practice with that of Parshall and of Siemens & Halske. 5000 w. Elektrotech Zeitschr—Feb. 28, 1901. No. 39948 B.

The Schuckert Dynamo at the Paris Exposition (Les Dynamos Schuckert au Palais de l'Electricité). G. Leugny. With illustrations of continuous and polyphase generators and details of switchboards and distribution. 2500 w. Revue Technique—Feb. 10, 1901. No. 39905 D.

Excitation.

Alternator Excitation. H. H. Norris and F. D. Newbury. Discusses the various methods used in the United States and Europe. Ill. 4000 w. Sib Jour of Engng—March, 1901. No. 39845 C.

Generating Project.

The Generation and Transmission of Electric Energy at and from Coal Pit Centers. B. H. Thwaite. The first of a series of articles on long-distance transmission, showing the tendency of modern practice. 1000 w. Elec Rev, Lond—March 1, 1901. Serial. 1st part. No. 39692 A.

Power Station.

The Trafford Park Power Works. Illustrated detailed description of the first electrical station to be worked in England with the special object of supplying power in bulk to large manufacturers. 2800 w. Elec Engr, Lond—March 15, 1901. Serial, 1st part. No. 40023 A.

Transformers.

Rotary Transformers: Their History, Theory and Characteristics. George W. Colles. A thesis presented in candidature for the degree of Master of Science in the Columbian University. A review of transforming devices, tracing their evolution from early beginnings to the present. Ill. 4800 w. Jour Fr Inst—March, 1901. Serial. 1st part. No. 39643 D.

LIGHTING.

Arc Light.

A New Method of Producing Electric Light (Ein Neues Verfahren zur Erzeugung von Elektrischen Licht). Ewald Rasch. Describing an arc lamp with electrodes of magnesia, lime, or other refractory substance, rendered conductors by heating. 2500 w. Elektrotech Zeitschr—Feb. 14, 1901. No. 39942 B.

Incandescence.

The Osmium Lamp. On the new incandescent lamp invented by Dr. Auer von Welsbach, possessing a filament formed of the rare metal osmium. Also editorial. 1800 w. Elec Wld & Engr—March 16, 1901. No. 39841.

Lowestoft, Eng.

Lowestoft Electricity Works. An illustrated detailed description of the electric lighting installation. 2200 w. Elec Engr, Lond—March 1, 1901. No. 39724 A.

Ship Lighting.

Electric Lighting for German Ships. Gives extract of an article in the *Elektrotechnische Zeitschrift* treating of electrical installations on new ships of the German navy. Also remark on the use of accumulators for supplying electric light on ocean steamers. 600 w. U. S. Cons Repts, No. 973—Feb. 28, 1901. No. 39547 D.

Signs.

Automatic, Changeable Electric Signs. Illustrated description of a new form of electric sign advertising. 1500 w. Sci Am Sup—March 23, 1901. No. 39854.

Street Lighting.

Street Lighting of Cities. Henry H. Humphrey. Briefly discusses the subject generally, and gives an illustrated description of the principal engineering features of the new electric lighting system in St. Louis. 4300 w. Jour Assn of Engng Socs—Jan., 1901. No. 39577 C.

Thames Embankment.

The Electric Lighting of the Thames Embankment. Illustrated description of the arrangements so far as carried out, with outline of the previous history. 1700 w. Elect'n, Lond—March 1, 1901. No. 39721 A.

MEASUREMENT.

Bridge.

Three Forms of Thomson Bridge for Small Resistances (Drei Formen der Thomson'schen Messbrücke für Kleine Widerstände). Dr. M. T. Edelmann. With illustrations showing the wiring of three forms of bridge for low resistances and views of the completed instruments. 1000 w. Elektrotech Zeitschr—Feb. 14. 1901. No. 39943 B.

Hysteresis.

Measurements of Dielectric Hysteresis. W. E. Ayrton. A discussion of the results obtained by Mr. Mordey and by Mr. Mather for the County of London cable. Ill. 1500 w. Elec Rev, Lond—Feb. 22, 1901. No. 39601 A.

Meters.

Electric Meter for Three-Phase Currents with Four Conductors (Elektricitätszahler für Dreiphasenstrom mit Vier Leitungen). H. Aron. Showing the construction and connections of this special form of Aron Meter. 1200 w. Elektrotech Zeitschr—March 7, 1901. No. 39954 B.

The Aron Meter for Mixed Three-Phase Currents (Compteur Aron pour Distributions Mixtes à Courants Triphasés). M. Aliamet. Showing the special winding adopted for use with mixed currents, with illustrations of the method of connection. 1200 w. Electricien—Feb. 23, 1901. No. 39933 B.

Slipping.

Measurement of the Slipping in Asynchronous Motors (Messung der Schlüpfung Asychroner Motoren). G. Seibt. The slip is determined from the vibrations of the needle of an amperemeter of which the terminals are connected to the contact rings of the armature. 1200 w. Elektrotech Zeitschr—Feb. 28, 1901. No. 39949 B.

Voltage.

A Method of Compensating Voltmeters for the Voltage Drop in Long Feeders. M. B. Field. Describing an arrangement of voltmeters in connection with series resistances indicating the average voltage over the whole network at every moment. Serial. 1st Part. 2300 w. Electn, Lond—Feb. 22, 1901. No. 39598 A.

Wattmeters.

The Theory and Use of the Alternate Current Wattmeter. Charles V. Drysdale. An explanation of the use of this instrument for power measurement, the errors to which it is liable, and how to correct them. 4000 w. Elect'n, Lond—March 15, 1901. No. 40045 A.

POWER APPLICATIONS.

Armatures.

Resistance, Current Distribution and Consumption of Energy in Short-circuited Armatures (Widerstand, Stromvertheilung und Energieaufnahme von Kurzschlussankern). M. Osnos. An examination of the advantages of short-circuited armatures for induction motors, showing the saving in copper over phase armatures. 3000 w. Elecktrotech Zeitschr—Feb. 21, 1901. No. 39945 B.

Brake Magnets.

Brake Electromagnets for Continuous Currents (Ueber Bremselektromagnete für Gleichstrom). Max Vogelsang. Describing the solenoid magnets used by the Helios company for operating the brakes for electric cranes. 2500 w. Elektrotech Zeitschr—Feb. 21, 1901. No. 39946 B.

Business Building.

Power Plant of the Western Reserve Building. Illustrates the plant for furnishing power to a large addition to the building, occupied by large mining, shipping, steel and iron companies. The plant consists of two water-tube boilers, of the cross drum type, and three 30 kilo-watt direct connected generators. 1700 w. Engr, U. S. A.—March 1, 1901. No. 39625.

Cranes.

Electrically Driven Cranes (Elektrisch Betriebene Hebezeuge). P. Uellner. A description of electric travelling cranes, gantries, and cantilevers, built by the *Compagnie Internationale d'Electricité*, of Liége, Belgium. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 2, 1901. No. 39922 D.

Electrically Driven Cranes (Ueber Elektrisch Betriebe Hebezeuge). A. Kolben. With details of motors, gearing and general construction of traveling cranes, hoists, etc., showing the progress made in the past five years. 3000 w. Elektrotech Zeitschr—Feb. 14, 1901. No. 39941 B.

100-Ton Electric Ladle Crane. An illustrated detailed description of a crane recently erected in an open-hearth shop for handling a 50-ton ladle for making large ingots for gun forgings. 1500 w. Engr, Lond—March 8, 1901. No. 39808 A.

Fans.

Development of Motor Fans. Alton D. Adams. Discusses briefly the early fan motors; the design of fan motors, and those in present use. 4000 w. Elec Wld & Engr—March 2, 1901. No. 39621.

Hoboken, N. J.

The Hoboken Power Plant of the United Electric Company of New Jersey. Illustrates and describes a plant changed from a belted plant containing engines and generators of various types and capacities, to a modern plant of direct-connected units, and the change of e. m. f. from 1040 to 2400, all accomplished without shutting down any circuit. 1500 w. Elec Wld & Engr—March 23, 1901. No. 40009.

Mining Plant.

Electrically Operated Mines in Europe. Frank C. Perkins. Illustrates and describes the Ferdnandsgrube electrical pumping plant, and the electric mine ventilators at Karwin. 600 w. Eng & Min Jour—March 30, 1901. No. 40086.

Electric Power Plant at the Hollertszug

Iron Ore Mine, Herdorf on the Sieg, Germany. States the conditions to be met, and gives illustrated description of the plant installed. 2300 w. Ir & Coal Trds Rev—Feb. 22, 1901. No. 39611 A.

Motor Regulation.

The Speed Control of Electric Motors. G. F. Packard. Describes the method which consists in varying the speed by varying the volume and pole face distribution of the magnetic flux. 1100 w. Ir Age —March 7, 1901. No. 39619.

Motors.

A New Arrangement of Motors (Eine Neue Motorschaltung). Hugo Grob. Describing a special method of connecting polyphase motors in series. 2500 w. Elektrotech Zeitschr—March 7, 1901. No. 39953 B.

Packing House.

Power Plant of the Cudahy Packing Co. Illustrates and describes a Kansas City plant, the power being furnished by two simple Buckeye engines, direct-connected to Crocker-Wheeler generators. 2500 w. Engr, U. S. A.—March 1, 1901. No. 39624.

Power Bills.

The Electrical Power Bills of 1900; Before and After. William L. Magden. Read before the Inst. of Elec. Engs. (Eng.). Considers the conditions which led to the bills of the past session, describes some of the main features of the bills, and urges the Inst. to determine what its attitude should be in regard to the application of electrical energy in England. 4800 w. Elect'n, Lond—March 1, 1901. Serial. 1st part. No. 39722 A.

Signs.

The Evolution of the Electric Sign. E. Trier. Illustrates and describes the various kinds of electric signs, especially those operated automatically. 1300 w. Elec Wld & Engr—March 2, 1901. No. 39622.

Voting.

Voting by Electricity. Describes a device it is proposed to place in the House of Representatives at Washington, enabling Representatives to vote and have their votes recorded and counted and displayed by electricity. 800 w. Elec Wld & Engr —March 23, 1901. No. 40012.

Workshop Driving.

Electrical Power in British Works. W. Geipel. Read before the Gloucester Engng. Soc. Briefly reviews the older methods of operating, showing the losses, and considers how far electricity can assist in overcoming these losses. 4200 w. Elec Rev, Lond—Feb. 22, 1901. Serial. 1st part. No. 39602 A.

TRANSMISSION.

Line Wire.

The Use of Aluminum Line Wire and Some Constants for Transmission Lines. F. A. C. Perrine and F. G. Baum. Discussion of the above named paper. 3800 w. Trans Am Inst of Elec Engs—Feb., 1901. No. 40000 D.

Long Distance.

Electrical Transmission from Coal Mines. Fred Wilson Hart. An illustrated account of the power for the Cochiti Gold Mining Co., transmitted 32 miles from the coal deposits at Madrid, New Mexico, with comparison of the old and new methods. 2800 w. Elec Wld & Engr—March 2, 1901. No. 39620.

Mine Transmission.

Electrical Transmission Direct from the Coal Mine. Frank C. Perkins. Brief illustrated description of a German coal mine plant at Easen-Ruhr, the current being used for lighting and power. 700 w. Ir Age—March 21, 1901. No. 39817.

Snoqualmie Falls.

The Power Transmission From Snoqualmie Falls. An illustrated detailed description of this great transmission plant of Washington, with a discussion of its topographical and meteorological features, by Charles H. Baker. 13600 w. Jour of Elec—Jan., 1901. No. 39849 C.

MISCELLANY.

Education.

On the Training of Electrical Engineers. John T. Nicolson. Abstract of a paper read before the Manchester Section of the Inst. of Elec. Engs. Urges the adoption of the laboratory in connection with schools of applied science, and gives suggestions as to the instruction desirable. 4200 w. Elect'n, Lond—Feb. 22, 1901. No. 39597 A.

Electrical Exports.

American Electrical Exports. Arthur Stanley Riggs. Discusses some of the conditions in China, Japan and the Turkish Empire favorable to export. 2700 w. Elec Rev, N. Y.—March 9, 1901. Serial. 1st part. No. 39716.

Nineteenth Century.

Important European Electrical and Engineering Developments at the Close of the Nineteenth Century. William J. Hammer. Illustrated detailed descriptions of the telephonograph, the Langen mono-rail, Nernst lamp, osmium lamp, gas engines, steam turbine, and other important inventions. 20600 w. Trans Am Inst of Elec Engs—Feb., 1901. No. 40003 D.

GAS ENGINEERING

Address.

Presidential Address at the Birmingham Meeting of the Midland Association of Gas Managers. Thomas Glover. A lengthy address dealing with many subjects of interest to gas engineers. Considers water gas, inclined retorts, naphthalene, distribution, coke ovens, burners, etc. Ill. 9600 w. Gas Wld—Feb. 23, 1901. No. 39599 A.

Presidential Address before the Manchester District Institution of Gas Engineers. Charles Wood. Relates the practice and experience at Bradford, Eng., and discusses some points of interest. 7800 w. Jour Gas Lgt—March 5, 1901. No. 39783 A.

Presidential Address before the Southern District Association of Gas Engineers and Managers. Corbet Woodall. The main theme of the address is public lighting, but other matters of interest are considered. 6500 w. Gas Wld—March 16, 1901. No. 40024 A.

Analytical Tests.

Some Analytical Tests Made in a Gas-Works Laboratory. F. G. Barber. Read before the Manchester and Dist. Jun. Gas Assn. Considers methods of testing purified gas for impurities; analysis of the bodies which rid the gas of its impurities; coal gas; by products, and special tests. 5000 w. Jour Gas Lgt—March 12, 1901. No. 39863 A.

Conveying Plant.

New Hot-Coke Conveying Plant at the Leeds Gas-Works. Illustrated detailed description. 2000 w. Jour of Gas Lgt—March 19, 1901. No. 40066 A.

Enrichment.

The Enrichment of Coal Gas. R. Hooton. Read before the Manchester Dist. Inst. of Gas Engs. Short paper introducing a general discussion of the subject. 5700 w. Jour Gas Lgt—March 5, 1901. No. 39784 A.

The Enrichment of Coal Gas. Report of the discussion at the meeting of the Manchester Dist. Inst. of Gas Engs. 6000 w. Gas Wld—March 16, 1901. No. 40025 A.

European Practice.

How They Do Things on the Other Side. F. H. Shelton. A paper read before the New England Assn. of Gas Engs. Notes on visits to 15 gas-works in Europe. 7700 w. Pro Age—March 1, 1901. No. 39566.

Gas Fires.

Radiant Heat from Different Varieties of Gas Fires. Thomas Fletcher. Reports measurements of asbestos fibre, ball fire, iron spray, and radiant reflectors. Shows the iron spray to be the most economical and effective. 700 w. Jour Gas Lgt—March 5, 1901. No. 39782 A.

Governors.

Some Sketches of Gas Governors. J. J. Humphreys, Jr. Read before the New England Assn. of Gas Engs. Reviews the history of gas governors, illustrating many types and giving brief descriptions. General discussion. 5800 w. Am Gas Lgt Jour—March 11, 1901. No. 39750.

Ignition.

Automatic Ignition of Gas. W. G. Hicks. Illustrates a new device and discusses the faults of those generally used. 1300 w. Jour Gas Lgt—March 5, 1901. No. 39781 A.

Incandescence.

Relation of Heating to Lighting. Power of Gas, with Special Reference to Incandescent Mantles. Herman Russell and Alfred H. White. Discusses the subject of testing incandescent mantles, and tests made, giving conclusions. 3300 w. Pro Age—March 15, 1901. No. 39788.

Maps.

Street Maps. Read before the Michigan Gas Assn. Illustrates and describes maps prepared for a gas company and found very satisfactory. 4600 w. Pro Age—March 15, 1901. No. 39787.

Paris Exposition.

Gas Lighting at the Paris Exposition. Walter S. Allen. Describes features of the exhibit of special interest to gas men. Discussion. 4500 w. Am Gas Lgt Jour—March 4, 1901. No. 39654.

Purification.

Remarks on Gas Purification. S. J. Fowler. Presented at meeting of the New England Assn. of Gas Engs. Describes the apparatus used at Springfield, Mass., the changes made and the reasons. Brief discussion. 2000 w. Am Gas Lgt Jour—March 4, 1901. No. 39652.

The Proportion of Sulphur Removed in Each Purifying Box. Carroll Miller. Read at meeting of the New England Assn. of Gas Engs. Describes the apparatus used and experiments made to determine the proportional amount of sulphur in the form of sulphuretted hydrogen removed from the gas by the oxide of iron in each box in a set of four. Discussion. 2500 w. Am Gas Lgt Jour—March 4, 1901. No. 39653.

Water Gas.

Carburetted Water Gas. Samuel Cutler, Jr. Abstract of paper read before the Inst. of Junior Engs. discussing the composition, chemical aspects, methods, etc. Ill. 4800 w. Jour Gas Lgt—March 5, 1901. No. 39785 A.

MARINE AND NAVAL ENGINEERING

Battleship.

The New Battleship "Russell." Describes one of the largest battleships of the British navy recently launched; the first of six, known as the Duncan class, which are also the fastest battleships of the navy. 2600 w. Engng—Feb. 22, 1901. No. 39607 A.

The New Italian Battleship Vittorio Emanuele III. Illustrated description of a novel design about to be built by Italy. 1200 w. Engr, Lond—March 15, 1901. No. 40039 A.

Boilers.

Babcock and Wilcox Boilers on the S. S. "Martello." Illustrated description of new boilers recently substituted for the return tube boilers. 1100 w. Engng—Feb. 22, 1901. No. 39604 A.

On Some Attempts to Increase the Efficiency of Marine Boilers. G. M. Brown. Read before the North East Coast Inst. of Engs. & Shipbuilders. Discusses the utilization of the heat of waste gases, the experiments of Mr. Isherwood, the use of retarders, etc. Ill. 4500 w. Engs' Gaz—March, 1901. No. 39720 A.

The Thornycroft-Marshall Water-Tube Boiler. Illustrated description of a new form of water-tube boiler. 1700 w. Engng—March 15, 1901. No. 40032 A.

Water-Tube Boilers in the Navy. Interim report of the committee appointed to examine into the suitability of various types of marine boilers for naval purposes, with editorial. 6000 w. Engng—March 15, 1901. No. 40034 A.

Cargoes.

Importance of Economizing Tonnage Facilities by Compact Stowage of Cargoes. Henry P. Jones. A discussion of matters relating to ocean transportation, especially the export of cotton. 2000 w. Eng News—Feb. 28, 1901. No. 39572.

Coaling.

The Coaling of Warships. J. R. Edwards. A full discussion of the question; need of improvements in bunkers, rapidity, best means of coaling warships, use of Temperley conveyors, coaling stations, and coal-handling appliances, coaling at sea, the Clarke automatic coaling and weighing barge, the Walsh coal and freight delivery vessels, the Miller marine cableway, and other related matters. Ill. 16500 w. Jour Am Soc of Nav Engs—Feb., 1901. No. 39587 H.

Cruisers.

British Armored Cruisers. Editorial discussion of recently launched battleships and cruisers. 2000 w. Engng—March 1, 1901. No. 39726 A.

Comment on the New Type of United States Protected Cruisers. T. H. Thomas. Brief review of the history of the cruisers, St. Louis, Milwaukee and Charleston, the bids for construction of which were received on February 1. Ill. 1500 w. Marine Engng—March, 1901. No. 39678 C.

H. M. S. "Good Hope" and "Bacchante." Engraving showing the stern of the "Good Hope" and the arrangement of the balanced rudder and the cutting away of the dead wood, with brief description. 1500 w. Engr, Lond—March 1, 1901. No. 39731 A.

Deutschland.

The Hamburg-American Liner "Deutschland." An illustrated description of interesting details of this fine Atlantic liner. 700 w. Engng—March 8, 1901. Serial. 1st part. No. 39815 A.

The Steamship "Deutschland" (Le Paquebot Transatlantique "Deutschland"). S. Gradier. A fully illustrated description of the Hamburg-American Line steamer. Two articles. 2 plates. 5000 w. Génie Civil—Feb. 16, 23, 1901. No. 39900 each D.

Dockyards.

Keyham Dockyard Extension. Illustrated description of a great extension scheme, to cost over £3,000,000 sterling, now under construction. It consists of a tidal basin, a closed basin with an entrance lock, and three graving docks. 2800 w. Transport—March 1, 1901. No. 39687 A.

Explosion.

Steam Pipe Explosion on S. S. Ventura Instantly Kills Five Men. An illustrated article giving an account of the mishap and the investigation into the causes. 2000 w. Marine Engng—March, 1901. No. 39677 C.

Ferryboat.

Elegant New Propeller Ferryboat. Illustrated description of the "West Point," the latest addition to the N. Y. harbor fleet. 1400 w. Naut Gaz—March 7, 1901. No. 39701.

Freighters.

Ocean Freighters Alaskan and Arizonian Building at Union Iron Works. Describes two interesting ships under construction at San Francisco, representing the most advanced practice of ocean going freighters. 1100 w. Marine Engng—March, 1901. No. 39680 C.

Fuel.

Petroleum Fuel for Ships; The Theory Exploded. Discusses the advantages and disadvantages of this fuel, and does not

think it likely to come into general use. 1800 w. Ir & Coal Trds Rev—Feb. 22, 1901. No. 39613 A.

Marine Railway.

The Marine Railway at the Royal Dock at Friedrichshafen (Der Schiffsaufzug der Kgl. Werft in Friedrichshafen). A. Seeman. The railway is at Friedrichshafen on the Lake of Constance and enables the lake steamers of 175 feet in length drawing 5 feet of water to be hauled out of the water for inspection and repair. 4000 w. Zeitschr d Ver Deutschr Ing—Feb. 23, 1901. No. 39920 D.

Passenger Boats.

New Fast Light-Draft River Propellers. Illustration and description of two fine passenger boats now being built for service on the upper Delaware. 1300 w. Naut Gaz—March 14, 1901. No. 39833.

Powder.

Smokeless Powder. Editorial discussion of the powder used by the British and its disadvantages, quoting from the address of Lieut. A. T. Dawson. 2100 w. Engng—March 15, 1901. No. 40036 A.

Powering.

The Powering of Ships. William Ledyard Cathcart. Presents the results of the best modern practice. Discusses the problem of resistance in its various forms, and of losses, model experiments, etc., and concludes that speed and power curves give the most trustworthy means of powering a proposed ship. Ill. 17800 w. Sch of Mines Quar—Jan., 1901. No. 39770 D.

Projectiles.

Capped Armor-Piercing Projectiles. P. M. Staunton. Deals with the development of each successive type, stating what it was intended to effect, and to what extent the expectations have been justified. 5200 w. Engng—March 15, 1901. No. 40035 A.

Schooners.

Modern American Wooden Schooners. Descriptions of two of the latest to be launched from Maine shipyards. 1100 w. Naut Gaz—March 21, 1901. No. 39865.

Shipbuilding.

Camden's Great Shipbuilding Plant. Describes the works of the New York Shipbuilding Co., the novel labor-saving appliances, the power, railroad connections, etc. 7500 w. Naut Gaz—March 21, 1901. No. 39866.

Decline in British Shipbuilding. Reports this branch of trade, as well as other lines, in anything but a prosperous condition. 2400 w. Naut Gaz—March 14, 1901. No. 39834.

New American Steel Shipbuilding Plants. Waldon Fawcett. A review of the new plants and improvements greatly increasing the American facilities. 2800 w. Ir Age—March 14, 1901. No. 39755.

Notes Taken at the Works of the Newport News Shipbuilding and Drydock Co., Newport News, Va. General information with illustrated description of the shops, important tools, special work, etc. 3000 w. Mach, N. Y.—March, 1901. No. 39663.

Ship Building in the United States. A discussion of the subject based upon the output at Cleveland as compared with other districts of the country. 1200 w. Marine Rev—March 21, 1901. No. 40013.

Ship Building Resources of Germany. From *N. Y. Sun*. Full text of M. Edouard Lockroy's letter on the merchant marine of Germany and the remarkable industrial growth of the nation. 3300 w. Marine Rev—March 21, 1901. No. 40014.

Sloop.

The Sloop-of-War St. Mary's. Illustrations with description and a summary of her history from the time of launching, her part in the Civil War, and her use as a Public Marine School, with a brief article describing life on board. 3800 w. Rudder—March, 1901. No. 39779 D.

Speed.

Speed of Steamers. Theodore Lucas. Discusses methods for finding the right horsepower and corresponding weight of machinery for a given displacement at a given speed, and gives information derived from experiments, diagrams, calculations, etc. 2000 w. Naut Gaz—March 7, 1901. No. 39702.

Steaming.

The Steaming Radius of United States Naval Vessels. B. C. Bryan. Gives tabulated information showing steaming radius of U. S. naval vessels, compiled from data of actual runs, as shown by steam logs, with comments. 3800 w. Jour Am Soc of Nav Engs—Feb., 1901. No. 39-588 H.

Steamships.

New Lake-Built Ocean Passenger and Freight Steamships. Briefly describes two steel vessels now under construction at Toledo, Ohio. Ill. 1000 w. Naut Gaz—March 21, 1901. No. 39864.

Submarine.

Holland's Speed Endurance Trial. A not very favorable report from Lieut. Com. John R. Edwards of the U. S. Navy. 3500 w. Marine Rev—March 7, 1901. No. 39754.

Gasoline Engines for Holland Submarine Torpedo Vessels Nos. 3 to 8. John Saltar, Jr. Reviews the history of the modern gas engine briefly, and describes the engines being built for these boats. 2200 w. Jour Am Soc of Nav Engs—Feb., 1901. No. 39589 H.

Submarine Navigation (La Navigation Sons-Marine). H. Noalhat. A complete study of the action of the various forces

upon a submerged boat. Serial. Part I. 3000 w. Revue Technique—Feb. 25, 1901. No. 39907 D.

The Holland Submarine Boat. Report prepared by Rear-Admiral O'Neil on the submarine boat Holland, with editorial. 6000 w. Engr, Lond—March 1, 1901. No. 39732 A.

Surf-Boat.

The U. S. Life-Saving Service Self-Bailing Water Ballast Surf-Boat. C. H. M'Lellan. Describes a useful and recent improvement in appliances for this service. Ill. 4400 w. Marine Engng—March, 1901. No. 39679 C.

Transports.

Transport Service to the Philippines. An account of the work of the Quartermaster's Department, especially the transportation of troops and supplies to the Philippines. Ill. 2000 w. Sci Am—March 23, 1901. Serial. 1st part. No. 39852.

Water-Ballast.

Rolling of Ships and the Effect of Water-Ballast. Bernard C. Laws. Read before the Inst. of Engs. & Shipbuilders in Scotland. Discusses the placing of the ballast so as to secure stability best for the particular vessel, and least calculated to produce excessive rolling. 3300 w. Engs' Gaz—March, 1901. No. 39719 A.

Yachts.

New Measurements for Yachts. Concerning the new rules adopted by the Seawanhaka Corinthian Yacht Club and which may become universal. 2400 w. Naut Gaz—March 14, 1901. No. 39835.

The New Cup Defender "Independence." Particulars of the Lawson boat building in East Boston with other items of interest connected with the coming international yacht races. 6000 w. Naut Gaz—March 7, 1901. No. 39703.

Yacht Yards.

A Flying Trip to Some English Yacht Yards in 1899. N. L. Stebbins. An account of visits to well-known yards with interesting illustrations. 2000 w. Rudder—March, 1901. No. 39780 D.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Agriculture.

Automobilism in Agriculture. Illustrates and describes several appliances shown at Paris, for plowing, mowing and other work. 1200 w. Sci Am Sup—March 16, 1901. No. 39778.

Artillery Motor.

A Motor Field Battery. Abstract of a paper read before the Royal Artillery Institution by Major H. A. Bethell. A discussion of the advantages and objections; giving also the details of a design for hauling guns by motor vehicles, which seems to promise well. 3000 w. Autocar—March 16, 1901. No. 40019 A.

Canada.

The Automobile Industry and Its Development in Canada. Briefly discusses the subject in general, and the progress in Canada. Ill. 3300 w. Can Elec News—March, 1901. No. 39861.

Carburetters.

Carburetters Condemned. Hugh Dolnar. Proving that the commonly used forms of carburetters are needless and troublesome, and briefly describing some recent patents for introducing liquid fuel to a motor cylinder. Ill. 2000 w. Autocar—Feb. 23, 1901. No. 39591 A.

Cost.

A Few Figures on Cost of Operating a Steam Automobile. George E. Greenleaf. Describes the carriage used and conditions under which it was run, giving a detailed statement of the cost of running. 1200 w. Auto Mag—April, 1901. No. 40049 C.

Explosion Motors.

Theoretical Calculations Concerning High-Speed Explosion Engines. P. Colardeau. Gives a method of calculating dimensions and powers within certain limits; the formulæ have been established as the results of trials and observations. 1800 w. Auto Jour—March, 1901. No. 40017 A.

Gasoline Carriage.

Design of a Light Gasoline Carriage. Illustrates and describes a design aiming to be as simple as is consistent with efficiency and strength. 2700 w. Horseless Age—March 13, 1901. No. 39758.

Ignition.

Ignition Wiring Methods. Dr. Henry Power. An illustrated discussion of the electric ignition problem as applied to gasoline engines. 600 w. Horseless Age—Feb. 27, 1901. Serial. 1st part. No. 39555.

Motor Difficulties.

Air-Cooled Motor Difficulties and How to Overcome Them. T. Parker Hall, Jr. An account of the writer's experiments and the lessons learned from them. 2000 w. Horseless Age—March 27, 1901. No. 40067.

Paris.

Motor Cars in Paris. Discusses the

progress being made in motive power, in transmission gears and other details. 1300 w. Engr, Lond—March 8, 1901. No. 39806 A.

Sparking.

Sparking Troubles. A discussion of the causes and remedies of sparking, written especially for users of gasoline automobiles or stationary gasoline engines. Ill. 3000 w. Horseless Age—March 20, 1901. No. 39848.

Steam Wagon.

The Thornycroft Steam Wagon. Illustrates and describes the American built wagons for heavy duty, which possess many interesting features. 1400 w. Ir Age—March 28, 1901. No. 40058.

Trials.

An Automobile Trial. J. L. Lucas. History of a trial run of an auto-carriage run by a kerosene burner using a flash boiler and an ordinary 4½ h. p. engine. 1100 w. Am Mach—March 21, 1901. No. 39868.

Electric Automobiles at Chislehurst. Review of the judges' report of trials made under the auspices of the Automobile Club of Great Britain and Ireland. 2000 w. Elec Rev, Lond—March 1, 1901. No. 39694 A.

Truck.

Electric Truck (Chariot Electrique). A. Bainville. Illustrated description of the heavy electric truck of 12 tons weight and 10 tons capacity used by the Say refinery of Paris. 1800 w. Electricien—Feb. 16, 1901. No. 39931 B.

Voiturette.

The Panhard Voiturette. Illustrated description of the carriage and mechanism. 1200 w. Autocar—Feb. 23, 1901. No. 39590 A.

HYDRAULICS.

Air Compression.

Water Power by Direct Air Compression. William O. Webber. Reviews some of the uses of compressed air and the old methods of mechanical compression, and also the methods of compressing air directly by falling water or under pressure. Ill. 3500 w. Jour Assn of Engng Socs—Jan., 1901. No. 39578 C.

Excavation.

Hydraulic Excavation. Latham Anderson. Discusses the processes employed, and the conditions essential to economy, outlining the process of opening and working on hydraulic mine, and other work of interest. Ill. 5500 w. Jour Assn of Engng Socs—Jan, 1901. No. 39576 C.

Pumping Engine.

A Report on Trial of 30,000,000 Gallon Pumping Engine at the Chestnut Hill High-Service Station of the Metropolitan Water Works, Made May 1 and 2, 1900. Will J. Sands. Gives a description of the plant and method of conducting the trial, with general data. 3400 w. Jour N. E. Water Wks Assn—March, 1901. No. 39637 F.

Pumps.

The Bridgeport Wheel Pumps. Ossian Guthrie. Describes the construction of two wheel pumps used between 1848 and 1871 for supplying the Illinois and Michigan Canal with a flow from the river. They proved an economical and efficient device and their advantages are urged for the purpose of elevating sewage and storm water into the big cross-town tunnels in Chicago. Plate. 1500 w. Jour W Soc of Engs—Feb., 1901. No. 39767 D.

The Kaselowsky-Prott Hydraulic Pump. Fr. Frolich. Translated from *Gluckauf*. An illustrated detailed description of improvements in the hydraulic pump which greatly increase its efficiency. 1500 w. Ir & Coal Trds Rev—Feb. 22, 1901. No. 39612 A.

Water-Wheels.

Some Recent High-Head Pelton Water Wheel Installations. George J. Henry, Jr. Illustrated account of some of the most prominent and recent installations of Pelton wheels in electric power transmission service. 3300 w. Jour of Elec—Jan., 1901. No. 39850 C.

MACHINE WORKS AND FOUNDRIES.

Artillery.

Modern Artillery. Arthur Trevor Dawson. Considers general governing principles and compares the different systems employed with a view of ascertaining the relative advantages and disadvantages. 10000 w. Jour Soc of Arts—March 8, 1901. No. 39800 A.

Nordenfelt's Quick-Firing Field Artillery. An illustrated description of field guns fitted with breech mechanism of the eccentric screw type, and carriages without hydraulic brake, in which the force of the recoil is taken up by a special wheel-brake. 3200 w. Engng—March 1, 1901. No. 39725 A.

Rapid Fire Guns, Ancient and Modern. E. G. Parkhurst. Illustrated description of ancient and modern guns of this class. 3500 w. Am. Mach—March 7, 1901. No. 39675.

The Manufacture of American Ordnance. Waldon Fawcett. Reviews the work of the past year at the different U. S. arsenals and machine works, illustrating many of the guns and describing the methods. 2500 w. Am Mfr—March 7, 1901. No. 39688.

The Manufacture of Rapid Fire Guns. E. G. Parkhurst. The present article deals

with the material, the physical tests, the leading operations and tools used. 2000 w. Ill. Am Mach—March 14, 1901. Serial. 1st part. No. 39759.

Bolts.

Bolts, Nuts, and Keys, and the Part They Play in Locomotive and Car Work. A topical discussion. Ill. 4500 w. Pro W Ry Club—Feb., 1901. No. 39829 C.

Brazing.

Brazing Solder. John Findlay. From *The Indian Textile Journal.* Describes the methods in use for making brazing solder, and gives the best mixtures for brazing brass, copper and steel. 600 w. Prac Engr—March 15, 1901. No. 40044 A.

Cam-Cutting.

Uniform Feed Cam-Cutting Machine. Illustrated description of an interesting cam-cutting machine used in the manufacture of cash registers. 700 w. Am Mach—Feb. 28, 1901. No. 39540.

Castings.

A Straight Casting from a Crooked Old Pattern. L. C. Jewett. Describes the method used with success. Ill. 900 w. Am Mach—March 21, 1901. No. 39867.

Copper Castings. Walter J. May. Directions for casting sound castings of this metal. 800 w. Prac Engr—March 15, 1901. No. 40043 A.

Cranes.

See Electrical Engineering, Power Applications.

Dies.

Solid and Built Up Dies. G. Schneider. Illustrates and describes a proposed die and its substitute. 900 w. Am Mach—March 14, 1901. No. 39761.

Wiring Dies for Shell Work. Joseph V. Woodworth. Illustrated description of dies for forming a sheet-brass shell. 600 w. Am Mach—March 14. 1901. No. 39760.

Forge.

The Old Boonton Forge. Brief illustrated description of a pre-revolutionary foundry where cannon balls were cast for the continental army, which is about to disappear in the building of a great reservoir. 600 w. Sci Am—March 16, 1901. No. 39773.

Lubrication.

The Friction of Lubricants at High Temperatures. (Die Reibung von Schmierölen bei Höheren Wärmegraden.) Dr. S. Kapff. A review of the experiments of Prof. Thurston and a comparison with German experiences as to temperature and viscosity. 2000 w. Zeitschr d ver Deutscher Ing—March 9. 1901. No. 39925 D.

Pattern Making.

Pattern and Core Boxes for a Water Jacketed Cylinder. W. O. Anthony. Illustrated description of the methods employed in the making of a set of patterns for a water jacketed cylinder and head. 1600 w. Horseless Age—March 6, 1901. Serial. 1st part. No. 39662.

Shop Construction.

The Cramp Machine Shop and Power House. Illustrated description of a 333 x 142 ft. steel frame machine shop and a 60 x 71 ft. power house; the description is confined to the structural details of the building. 2300 w. Eng Rec—March 9, 1901. No. 39699.

The New Detroit Shops of the Boyer Machine Company. New shops prepared for a company removing from St. Louis are illustrated and described in detail. 2200 w. Am Mach—March 7, 1901. No. 39676.

The New Works of the Alabama Steel and Shipbuilding Company. Archibald Potter Head. Illustrated description, with history and other information. 5000 w. Ir & Coal Trds Rev—March 15, 1901. No. 40028 A.

The Schenectady Works of the General Electric Company. The first of a series of articles giving illustrated description of the equipment of these fine shops. The present paper gives a general view of the works and the methods. 2200 w. Elec Rev, N. Y.—March 16, 1901. Serial. 1st part. No. 39786.

Shop Hygiene.

The Economy of Heating and Ventilating the Machine Shop. L. Allen. A discussion of the influence of personal comfort upon individual efficiency, showing how bad hygienic conditions reduce quality and rate of out-put. 3000 w. Engineering Magazine—April, 1901. No. 39966 B.

Tubing.

Diescher Billet Piercing Process. Illustrated description of a new method for piercing billets to be used in the manufacture of seamless tubing. Gives illustrations showing the important steps in the art since its introduction by M. Mannesmann in Germany. 1800 w. Ir Trd Rev—Feb. 28, 1901. No. 39548.

Workshop Driving.

See Electrical Engineering, Power Applications.

MATERIALS OF CONSTRUCTION.

Rubber.

The Recovery of Naphtha in India-Rubber Works. Calls attention to points connected with the recovery and means of obtaining satisfactory results. 2400 w. Engng—March 8, 1901. No. 39816 A.

Steel.

An Experimental Study of the Causes of the Fragility of Steel (Etude Experimentale des Causes de la Fragilité de l'Acier). Ch. Fremont. The method of M. Fremont of bending tests of small cross-ruled bars is employed to investigate the nature and deformation of brittle steels. 5000 w. Bull Soc d'Encour—Feb., 1901. No. 39912 G.

Microstructure of the Steel in a Defective Circular Saw. James A. Aupperle. Brief illustrated account of microscopic examination to determine the cause of the failure. 450 w. Eng News—March 7, 1901. No. 39670.

POWER AND TRANSMISSION.

Ball Bearings.

Experiments on the Permissible Pressure on Ball Bearings (Versuche über die Zulässige Belastung von Kugeln und Kugellagern). Dr. W. Schwinning. Experiments to determine the deformation and crushing resistance of balls under the conditions of use for bearings. 3000 w. Zeitschr d Ver Deutscher Ing—March 9, 1901. No. 39923 D.

Belts.

Belt Drive for Three Pulleys. Forrest R. Jones. Calculations where two pulleys are driven with a single belt by a third pulley. 2000 w. Mach, N. Y.—March, 1901. No. 39664.

High-Speed Belt Transmission. A report of statements by C. O. Gehrckens on experiments with very high speed belts, claimed to disprove the theories of Rankine and others on this subject. 1600 w. Eng Rec—March 30, 1901. No. 40079.

Compressed Air.

Compressed Air. Considers its compression, storage and distribution, and its use as a motive power. 2500 w. Auto Jour—March, 1901. Serial. 1st part. No. 40018 A.

Dynamometer.

Electric Precision Brake-Dynamometer (Elektrisches Präcisions Bremsdynamometer). E. H. Rieter. The device is similar to a Prony brake, with the friction band replaced by a ring magnetic field. The heat generated is dissipated by air-cooled ribs. 2000 w. Elektrotech Zeitschr—Feb. 28, 1901. No. 39950 B.

The Design and Installation of an Alden Absorption Dynamometer. C. M. Allen. Illustrates and describes this apparatus and its operation. It is compact, easily handled and automatic in regulation. 1400 w. Jour Worcester Poly Inst—March, 1901. No. 39843 C.

Gearing.

Construction of Lobed Wheels. Robert A. Bruce. An illustrated description of a method of constructing lobed gearing. 2300 w. Prac Engr—Feb. 22, 1901. Serial. 1st part. No. 39594 A.

Pipe Lines.

Petroleum Oil Pipe Lines. A. S. Cooper. Considers the cases that may arise in constructing an oil line, means of finding the fluidity of the oil and therefore the flow. Ill. 1600 w. Min & Sci Pr—March 9, 1901. No. 39757.

Wire Ropes.

Wire ropes. J. T. Beard. A reference to some important facts shown by experiments described in a paper by Andrew S. Biggart, in Pro. Inst. of Civ. Engs. 3000 w. Mines & Min—March, 1901. No. 39713 C.

SPECIAL MOTORS.

Explosion Motors.

See Automobilism.

Gas Engines.

A Test of a Gas Engine Electric Lighting Plant. H. N. Cheney read before the New England Assn of Gas Engs. Describes a test made at the Mechanics' Building, Boston, of a plant used for exhibition purposes at a fair. Ill. and discussion. 8,000 w. Am Gas Lgt Jour—March 11, 1901. No. 39749.

Tests of a Gas Engine Using Electric and Hot-Tube Igniters. An account of some tests made in Boston on a 20-H. P., two-cylinder engine at various loads. 600 w. Eng Rec—March 30, 1901. No. 40078.

Tests of Gas Motors and Generators (Essais de Moteurs à Gaz et de Gazogènes). An account of tests of Crossley gas engines and Pierson generators at the tramway station at Cassel (France). 1200 w. Génie Civil—Feb. 23, 1901. No. 39901 D.

The Insistent Operative Conditions of the Gas Engine. W. Osborne. On the importance of having an intelligent engineer to so regulate the engine as to bring the best conditions for efficiency. 1400 w. Am Mach—Feb. 28, 1901. No. 39541.

Fly Wheels.

The Computation of Fly Wheels for Internal Combustion Motors (Berechnung des Schwungradgewichtes der Verbrennungsmotoren). H. Güldner. A discussion of the proper weight for two and four cycle motors to give a predetermined steadiness of motion. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—March 16, 1901. No. 39926 D.

See Steam Engineering.

Heat Engines.

A Method of Cy lic Analysis of Heat Engines. Charles E. Lucke. Outlines various cycles and considers them, causing one pound of air to pass through each

under ideal conditions. Mathematical. 4000 w. Sch of Mines Quar—Jan., 1901. Serial. 1st part. No. 39771 D.

Internal Combustion.

The Secor Internal Combustion Engine. John A. Secor. States the present position of gas engines and gives illustrated description of engine named. 3300 w. Eng News—March 28, 1901. No. 40057.

Solar Motors.

Solar Motors. Charles F. Holder. An illustrated description of a solar motor at work at Los Angeles, Cal., with history of its development. 1500 w. Sci Am—March 16, 1901. No. 39777.

STEAM ENGINEERING.

Blowing Engine.

Horizontal Blowing Engine with Suspended Valves (Liegende Hochofen-Gebläsemaschine mit Lenkerventilen). H. Hoerbiger. Illustrated description of engine for blast furnace service. The air valves are supported on spring links. 4500 w. 2 plates. Zeitschr d Ver Deutsch Ing—Feb. 16,1901. No. 39917 D.

Boilers.

The Steam Boilers at the Paris Exposition (Die Dampfkessel der Pariser Weltausstellung). F. Krauss. A general review of the steam boilers exhibited at Paris, with details of arrangement and construction. Serial. Part I. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—March 8, 1901. No. 39929 B.

See Marine & Naval Engineering.

Condensers.

Condensers for Steam Engines (Les Condenseurs de Machines à Vapeur). J. Nadal. The first portion of an exhaustive study of the advantages of the use of condensers, and a description of modern condensing machinery for use with steam engines. Serial. Part I. 7500 w. Revue de Mécanique—Feb., 1901. No. 39913 H.

Engines.

Horizontal Steam Engine of 1200 Horse Power (Machine à Vapeur de 1200 Chevaux). Illustrated description of the triple-expansion, poppet-valve engine exhibited at Paris by F. Tosi, of Legnano, Italy. 1200 w. 1 plate. Génie Civil—March 2, 1901. No. 39903 D.

Recent Types of American and European Engines. Illustrates and describes the new engines for the Brooklyn Edison plant, and a Russian engine for electric lighting service. 2500 w. Am Elect'n—March, 1901. No. 39684.

The Westinghouse-Corliss Engine. Illustrates and describes in detail this vertical cross compound engine. 1700 w. Power—March, 1901. No. 39617.

Fly Wheels.

The Strength of Fly Wheels (Festigkeit der Schwungräder). R. Bredt. A mathematical examination into the nature and magnitude of centrifugal stresses and strains on fly wheels, with formulas for safe design. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 23, 1901. No. 39921 D.

See Special Motors.

Fuel.

A New Method of Burning Powdered Fuel. Illustrates and describes the system of William Westlake, which provides a grate upon which a small fire of ordinary coal is maintained. 1500 w. Eng News—March 14, 1901. No. 39790.

See Marine & Naval Engineering.

Heating.

Heating from Central Stations—A Comparison with Private Heating Plants. Alton D. Adams. A statement of the advantages of distributing steam heat from electric stations. 1700 w. Munic Engng—March, 1901. No. 39646 C.

Hot-Water Central Heating in Red Oak, Ia. Illustrated description of a plant with 5,500 ft. of steel mains and 29,000 sq. ft. of radiation, operated to utilize the exhaust steam of an electric station. 1500 w. Eng Rec—March 30, 1901. No. 40080.

Hot Water Heating from Central Stations. Alton D. Adams. Discusses the advantages of such a system, and its efficiency. 2800 w. Elec Wld & Engr—March 23, 1901. No. 40011.

Heating Surface.

The Theory of Ribbed Heating Surface (Zur Theorie der Rippenheizkörper). G. Rothgiesser. An examination of the advantages of using extended or ribbed surfaces for radiators, showing the necessity of providing sufficient thickness of rib to conduct the heat. 1200 w. Gesundheits-Ingenieur—Feb. 28, 1901. No. 39939 B.

Mechanical Draft.

Fuel Combustion with Draft Furnished by Mechanical Methods. W. W. Christie. A critical comparison of the relative advantages of natural and chimney draft, showing the conditions under which either is to be preferred. 3000 w. Engineering Magazine—April, 1901. No. 39967 B.

Mechanical Plant.

Some Engineering Features in the Development of a Country Estate. Illustrated description of the heating, lighting and plumbing on a notable country estate of 600 acres, near New York. 4000 w. Eng Rec—March 16, 1901. No. 39826.

Pipe Covering.

Mica Insulation for Steam Boilers and Pipes. Gives some figures showing the loss of heat in steam boilers and steam

pipes, and the results obtained in experiments with various coverings, showing that 90 per cent. is saved by the use of mica insulation. 1600 w. Engng—Feb. 22, 1901. No. 39605 A.

Piston Rings.

Elastic Piston Rings (Selbstspannende Kolbenringe). K. Reinhardt. A mathematical investigation of the forces acting in elastic spring packing rings for steam engine pistons, with tables for practical use and examples of their application. Two articles. 10000 w. Zeitschr d Ver Deutschr Ing—Feb. 16, March 16, 1901. No. 39919 each D.

Steam Power.

Steam Engineering in the United States in 1838. An abstract of a report by the secretary of the treasury containing a census of the stationary, locomotive and marine engines in use up to that time in the U. S. and an account of the accidents in steam plants. 2400 w. Eng Rec—March 16, 1901. No. 39825.

Turbines.

Steam Turbine: Its Development and Use. Abstract of a lecture by Konrad Anderson in the "De Laval Steam Turbine," given at Keighley Institute. 1100 w. Engr, Lond—March 15, 1901. No. 40-040 A.

The Seger Compound Steam Turbine (Turbine à Vapeur Compound). A combination of two disks of the De Laval type, rotating in opposite directions. 1200 w. Génie Civil—March 9, 1901. No. 39-904 D.

Water Gauges.

Glass Tubes for Water Gauges (Wasserstandsröhren und ihre Schutzgläser). O. Schott & M. Herschkowitsch. An account of experimental tests comparing French, English, and Scotch tubes with tubes of the improved Jena glass. 2500 w. Zeitschr d Ver Deutscher Ing—March 9, 1901. No. 39924 D.

MISCELLANY.

Address.

President's Annual Address Before the Engineers' Society of Western Pennsylvania. W. A. Bole. Progress during the century just completed, dealing only with the industrial side. 5500 w. Pro Engs' Soc of W Penn—Jan., 1901. No. 39799 D.

Aeronautics.

The Kress Aeroplane. Brief illustrated account of the invention of W. Kress, a German engineer. 450 w. Sci Am—March 2, 1901. No. 39543.

Agreement.

Philadelphia Molders' and Founders' Agreement. A copy of the agreement between the National Founders' Assn. on behalf of its Philadelphia members, and the Iron Molders' Union of North America, on behalf of its Philadelphia members. 2400 w. Ir Trd Rev—March 7, 1901. No. 39751.

Beet Sugar Works.

The Beet Sugar Industry in Utah. W. P. Hardesty. Illustrates and describes the method of making beet sugar at Lehi, Utah; the seventeen stages of the process are explained and the apparatus briefly described. 5200 w. Eng Rec—March 2, 1901. No. 39633.

Exhibition.

Glasgow International Exhibition. The present article gives an illustrated description of the machinery section, being devoted almost exclusively to the housing provided, but briefly indicating the extent and character of the provision made for power and lighting purposes. 4300 w. Engr, Lond—Feb. 22, 1901. Serial. 1st part. No. 39609 A.

Factory Communities.

Village Communities of the Factory Machine Works, and Mine. C. B. Going. Giving many illustrations of the working out of the practical problems of living connected with new industrial conditions. 4000 w. Engineering Magazine—April, 1901. No. 39964 B.

Heat Losses.

Loss of Heat from Buildings. R. Gordon Mackay. Information collected by the writer concerning the transmission of heat through the various materials commonly used by engineers. 1600 w. Prac Engr—March 8, 1901. Serial. 1st part. No. 39-811 A.

Manufactures.

British Manufactures and the Policy of Unfettered Commerce. Edward Atkinson. An advocacy of free competition in open markets as against a war of tariffs. 5000 w. Engineering Magazine—April, 1901. No. 39961 B.

Organization.

The Organization of Manufacturers. Antonio C. Pessano. Read before the Foundrymen's Ass'n of Philadelphia. Claiming it a necessity to obtain the best results from organized labor, and giving the Philadelphia and New York agreements. 6600 w. Ir Age—March 14, 1901. No. 39756.

Paper Machinery.

Machinery for the Manufacture of Paper (Die Maschinen für Papier-Fabrikation). A. Pfarr. A general description of the paper-making machinery exhibited at the Paris Exposition of 1900. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Feb. 16, 1901. No. 39918 D.

Paris Exposition.

The Machinery and Transportation Exhibit at the Paris Exposition of 1900. Prof. Storm Bull. The writer's personal impressions of these exhibits, with remarks by others. 12000 w. Pro W Ry Club—Feb., 1901. No. 39828 C.

Refrigeration.

Cold Storage at the Paris Exhibition. An account of the exhibits, describing the plants. 3000 w. Engr, Lond—March 15, 1901. No. 40037 A.

Russia.

Engineering Opportunities in the Russian Empire. A. H. Ford. An exposition of the vast demands for machinery and for technical skill in the exploitation of the natural wealth of the Russian empire. 3000 w. Engineering Magazine—April, 1901. No. 39963 B.

Tariff.

American Tariff Measures Now Shutting the Open Door. W. L. Saunders. A discussion of the effect of the imposition of the countervailing duty on Russian beet sugar, upon the export of American machinery to Russia. 5000 w. Engineering Magazine—April, 1901. No. 39962 B.

Typesetting.

The Paige Typesetting Machine. Illustrated description of a most complicated piece of mechanism which sets, justifies and distributes foundry types with speed and precision. Also Editorial. 3200 w. Sci Am—March 9, 1901. No. 39685.

Ventilation.

Ventilation and Heating in a Paterson, N. J., Schoolhouse. Illustrated description of the method of ventilating and heating a 24-room school by apparatus occupying a notably small portion of the building's area and contents. 1900 w. Eng Rec—March 9, 1901. No. 39700.

Ventilating and Heating the Boston Music Hall. Illustrated description of plant for a large auditorium heated by direct radiation, using steam from an electric lighting plant; ventilation is secured by a combined plenum and exhaust system, the air entering at the top of the room. 3000 w. Eng Rec—March 2, 1901. No. 39635.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Cerrillos Anthracite Mines. Arthur Lakes. Describes a New Mexican coal mine which illustrates the metamorphosis of bituminous into anthracite. 1200 w. Mines & Min—March, 1901. No. 39706 C.

Alabama.

The Warrior Coal Basin. Henry McCalley. From reports of the Alabama Geol. Survey. Describes the basin area and the deposits. 2500 w. Ir & Coal Trds Rev—March 15, 1901. No. 40027 A.

Dust Prevention.

Apparatus for Laying Coal Dust (Einrichtungen zur Unschädlichmachung des Kohlenstaubes). H. Winkhaus. An examination of the cost of installing sprinkling apparatus in the mines of the Cologne Mining Company at Altenessen. 2500 w. Glückauf—March 2, 1901. No. 39937 B.

France.

Present Condition of the Coal Market in France. Discusses the question of reducing the cost of ocean transportation of coal so as to enable the United States to compete with Gt. Britain in supplying European markets. 1200 w. U. S. Cons Repts, No. 994—March 26, 1901. No. 40016 D.

Iowa.

An Iowa Coal Mine. Illustrated description of mine known as Cleveland No. 4. 900 w. Eng & Min Jour—March 23, 1901. No. 40015.

Appanoose County Coal Field. J. J. Rutledge. A description of the coal, the methods of mining and the use of machines in thin veins. 2600 w. Mines & Min—March, 1901. No. 39708 C.

Mexico.

Las Esperanzas Coal Mines, Mexico. Edwin Ludlow. Illustrated description of mines and coke oven plants. 1000 w. Eng & Min Jour—March 16, 1901. No. 39830.

New Mexico.

A New Coal Field in Northwestern New Mexico. Arthur Lakes. An account of an exploring expedition in a comparatively unknown region. Ill. 2500 w. Mines & Min—March, 1901. No. 39714 C.

Ohio.

Names for the Formations of the Ohio Coal-Measures. Charles S. Prosser. Reviews the formations of Ohio, showing that their limits correspond to those of Pennsylvania, and proposing that the same names be used. 2500 w. Am Jour of Sci—March, 1901. No. 39644 D.

Pittsburg.

Beginning and Development of Pittsburg's Coal Industry. Edgar W. Hassler. Brief review of the early history of this important industry. 2000 w. Am Mfr—March 7, 1901. No. 39689.

Pumps.

The Pumping and Spraying Arrangements at a Bohemian Colliery. A. Padour, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrated description of Riedler pumping engines and spraying devices to keep the mines cool. 2000 w. Col Guard—Feb. 22, 1901. No. 39614 A.

Shropshire.

The Unconformity in the Coal Measures of the Shropshire Coalfields. William James Clarke. Illustrated description of the positions of the beds, with explanations regarding them. 3000 w. Col Guard —Feb. 22, 1901. No. 39616 A.

Thin Seams.

The Working of Thin Coal Seams. Information from the presidential address of John Gerrard, before the Midland Inst. of Mining, Civil & Mech. Engs., showing the extent to which these seams are being worked in Great Britain. 1300 w. Col Guard—March 8, 1901. No. 39805 A.

Vancouver.

Coal Mining on Vancouver Island. An account, with illustrations, of the three collieries worked last year. 1100 w. Col Guard—March 1, 1901. No. 39727 A.

Windber.

The Windber Mine. J. S. Cunningham. Read before the Western Penn. Cen. Min. Inst. Plan of mine with description of underground haulage and mining methods as installed and used at Windber, Pa. 1800 w. Mines & Min—March, 1901. No. 39705 C.

COPPER.

Leaching.

Leaching Copper Ores by Sulphurous Acid. E. P. Jennings. Read before the Canadian Min. Inst. Describes the process patented in the United States by James W. Neill, suitable both for sulphide and oxidized ores, the former being first roasted to expel the sulphur and convert the copper compounds into oxides. 900 w. Can Min Rev—Feb. 28, 1901. No. 39669 B.

Wyoming.

Wyoming Copper Fields. Grant Jones. A résumé of the southern Wyoming copper fields and their development. Ill. 5800 w. Ores & Metals—March, 1901. No. 39793.

GOLD AND SILVER.

Analysis.

Analysis of Chloridized Ores. P. J. Thibault. Deals with a method of proximate analysis of chloridized ores, which are free from arsenic, antimony and lime. 3200 w. Aust Min Stand—Jan. 31, 1901. No. 40005 B.

Australia.

Gold Mining and Milling in Western Australia. A. G. Charleton. Mr. Charleton's third paper deals with the water problems of the region, and the manner in which they have been solved. 4000 w. Engineering Magazine—April, 1901. No. 39968 B.

Cape Nome.

Notes on Nome, and the Outlook for Vein Mining in that District. Forbes Rickard. The writer's opinion concerning the gold deposits, their origin, etc. 2000 w. Eng & Min Jour—March 2, 1901. No. 39567.

Chlorination.

Chlorination Mills at Cripple Creek, Colorado. Arthur Lakes. Illustrated description of the methods used in handling the ore and the application of the process. 2800 w. Mines & Min—March, 1901. No. 39704 C.

Cyanide Process.

Notes on the Assay of the Zincy Precipitates Obtained in the Cyanide Process. Charles H. Fulton and Charles H. Crawford. Describes work performed in the endeavor to evolve a short and accurate method which can be used in a custom assay office or mill. Tabulated information of assays made is given. 2700 w. Sch of Mines Quar—Jan., 1901. No. 39769 D.

Siemens-Halske Cyanide Process. John B. C. Kershaw. A review of this electrochemical process and its degree of success. Considers that neither the anodes nor the cathodes answer the requirements of a perfectly satisfactory process. 1500 w. Aust Min Stand—Jan. 24, 1901. No. 39539 B.

Extraction.

Electrolytic Processes for Gold Extraction. Alfred T. Weightman. Some of the methods which have been proposed are discussed and the difficulties met in their operation. 2200 w. Mines & Min—March, 1901. No. 39712 C.

Gold Milling.

Notes on Gold Milling Practice at the Athabasca Mine, Nelson, B. C. E. Nelson Fell. Read before the Canadian Min. Inst. Of interest because of the peculiar character of the ore treated. The general features are a hard blueish quartz, containing a large proportion of sulphides of zinc, lead and iron, showing free gold only when the ore is of fair grade. 2500 w. Can Min Rev—Feb. 28, 1901. No. 39668 B.

Mexico.

Mining Camps Near Topia, Durango, Mexico. Frank B. Fowler. Brief accounts of Canelas, Birimoa, Guaysimillas, La Bajada, Tamazula, etc., worked principally for the gold and silver deposits. 1200 w. Eng & Min Jour—March 16, 1901. Serial. 1st part. No. 39832.

Queensland.

Mining in Queensland. Donald Clark. Discusses the treatment of auriferous ores in various places. The present article considers Charters Towers. 1600 w. Aust Min Stand—Feb. 14, 1901. Serial. 1st part. No. 40008 B.

Similkameen River.

The Great Lower Similkameen. An account of important deposits of gold, silver, iron and copper in British Columbia, Reviewing briefly the mining history of the district. 2800 w. B. C. Min Rec—March, 1901. No. 39862 B.

Slimes.

Saving Slimes. W. C. Clark. An account of experiments in the recovery of valves which have gone to waste in tailings from concentrators of lead-silver ores. 1800 w. Mines & Min—March, 1901. No. 39707 C.

Tailings.

The Treatment of Highly Acidic Tailings by the Cyanide Process. F. B. Stevens. An account of difficulties encountered in treating the large heaps of accumulated tailings of the Transvaal goldfields. 1700 w. N. Z. Mines Rec—Jan. 16, 1901. No. 39628 B.

Telluride.

Telluride Ores. T. A. Rickard. Concerning the treatment of these ores at Cripple Creek and Kalgoorlie. 3000 w. Aust Min Stand—Jan. 31, and Feb. 7, 1901. No. 40004, 2 parts, each B.

Transvaal.

Taxes and Labor in Transvaal Mines. From the London *Economist*. Discusses the prospect of reducing working costs in the gold mines. 1700 w. Eng & Min Jour—March 16, 1901. No. 39831.

IRON AND STEEL.

Blast Furnace.

American Steel and Wire Company's New Blast Furnace at Neville Island. Christian Larsen. An illustrated description of a modern blast furnace plant being erected near Pittsburg, with a capacity greater than any furnace in existence. 1800 w. Am Mfr—Feb. 28, 1901. No. 39627.

A Modern American Blast Furnace—Its Construction and Equipment. Arthur C. Johnston. Describes the construction of a modern furnace, its equipment and the appliances for concentrating and handling the enormous amount of material required, drawing conclusions based on the operation. Ill. 7 plates. 4700 w. Jour Assn of Engng Socs—Jan., 1901. No. 39579 C.

Grading.

Erratic and Systematic Grading of Pig Iron by Analysis. Thomas D. West. A discussion of the methods adopted in grading pig iron by analysis with suggestions aiming to bring about uniformity. 1600 w. Jour Am Found Assn—March, 1901. No. 39585.

Iron Sand.

Notes on the Magnetic Iron Sand of the North Shore of the St. Lawrence. J. Obalski. Read before the Canadian Min. Inst. Historical sketch of the attempts to work these deposits profitably, and a study of their character. 2200 w. Can Min Rev—Feb. 28, 1901. No. 39667 B.

Rolling Mills.

Some Landmarks in the History of the Rolling Mill. Charles H. Morgan. Retiring presidential address before the Am. Soc. of Mech. Engs., Dec. 4, 1900. Historical review of its development, showing the important effect it has had on the material welfare of the country. Ill. 1100 w. Jour Worcester Poly Inst—March, 1901. No. 39842 C.

Separation.

Some Applications of the Wetherill Process of Magnetic Separation of Iron Ores. An abstract translation of a paper read at the Paris Exposition, by M. Smits, describing this process. 1500 w. Eng & Min Jour—March 30, 1901. No. 40085.

Steel.

A. J. Moxham on Steel Making in Canada. Address before the Canadian Mfrs' Assn. On Canada's advantages in steelmaking. 4400 w. Ir Trd Rev—Feb. 28, 1901. No. 39549.

Steel Billets.

The History of the 4-Inch Steel Billet in the United States. William Garrett. 3200 w. Ir & Coal Trds Rev—March 8, 1901. No. 39814 A.

Steel Trust.

American Trusts and British Industries. States the problem and discusses the purposes of trusts, the management, and methods of organized industry, etc. Also editorial. 4000 w. Ir & Coal Trds Rev—March 1, 1901. Serial. 1st part. No. 39729 A.

The Great Steel Trust. Editorial discussion of the great consolidation recently consummated in the United States. 1200 w. Engr, Lond—March 8, 1901. No. 39809 A.

The United States Steel Corporation. Editorial discussion of this vast consolidation and the effect on many industries. 2000 w. Eng News—March 7, 1901. No. 39672.

Sweden.

Some of the Iron and Steel Industries of Sweden. Robert W. Hunt. A lecture delivered before Sibley College. Briefly reviews the history of this important industry and describes visits paid to a few of the mines and works. 6500 w. Sib

Jour of Engng—March, 1901. No. 39844 C.

MINING.

Ancient Mines.

Ancient Miners of Lake Superior. Information concerning the traces of a race which antedates the memory of the Indians, and of their workings, and their familiarity with the copper deposits. 3800 w. Marine Rev—March 14, 1901. No. 39836.

Boring.

Boring Rods (Ueber die Bohrstange). W. Wolski. An examination of the dimensions and strength of rods for making deep bore holes. 2000 w. Glückauf—March 9, 1901. No. 39938 B.

British Columbia.

Mining Practice at Rossland, British Columbia. R. B. Brinsmade. Illustrates and describes the methods of development at War Eagle and Centre Star. The diamond drilling, shaft sinking, drifting, raising, blasting, trimming, hoisting, ventilation, lighting, pumping, air compression, etc., and costs. 6000 w. Mines & Min—March, 1901. No. 39711 C.

Dams.

Erection of Mine Dams at Pribram. Illustrated description of novel methods and the results attained in Bohemia. 900 w. Col Guard—March 15, 1901. No. 40029 A.

Dam Construction in the Mines at Pribram, Bohemia (Verdämmungsbauten beim Pribramer Hauptwerke). F. Mladek. With illustrations of wooden and masonry dams used in closing mining tunnels against water. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 2, 1901. No. 39936 B.

Mine Dams. James MacNaughton. Read before the Lake Superior Mining Inst. An interesting description of dam construction in Chapin Mine. Ill. 2100 w. Eng News—March 21, 1901. No. 39860.

Explosive Gas.

Explosive Gas in a Metalliferous Mine. Read before the Inst. of Min. & Met., London. F. W. Grey. Notes on an unusual occurrence observed in the Hutti mine in India, while undertaking the development of old native gold workings. 1400 w. Col Guard—March 1, 1901. No. 39728 A.

Explosives.

A Brief Sketch of the Essential Requisites of "Powder" as Distinguished from "Explosives." Dr. W. J. Williams. Address of the retiring president setting forth the requirements of a powder and of an explosive. 3800 w. Jour Fr Inst—March, 1901. No. 39642 D.

The Ignition of Explosives. A discussion of the advantages and costs of the various methods. 2100 w. Col Guard—March 8, 1901. No. 39804 A.

Exposition.

Mining Material at the Exposition of 1900 (Exposition Universelle de Paris 1900. Le Matériel des Mines). A. Habets. The first instalment of a description of boring, drilling, cutting, hoisting, and other mining appliances exhibited at Paris. Serial. Part I. 7000 w. 3 plates. Rev Univ des Mines—Feb., 1901. No. 39914 F.

Fans.

The Guibal Ventilating Fan. Fan described by John W. Robinson, in the *Journal* of the British Soc. of Min. Students, with the result of experiments. Ill. 1200 w. Col Guard—March 15, 1901. No. 40031 A.

Mining Plant.

See Electrical Engineering, Power Applications.

Mine Transmission.

See Electrical Engineering, Transmission.

Mining.

Mining. A. J. Bensusan. On the general subject of mining, discussing prospecting, exploration, exploitation, metallurgical treatment, etc. 3600 w. Aust Min Stand—Feb. 7, 1901. No. 40006 B.

Paris Exposition.

Mining at the Paris Exposition. David T. Day. A lecture before the Museum of Natural Hist., New York City. Describes the peculiar features of the industry as there illustrated. 1300 w. Mines & Min—March, 1901. No. 39709 C.

Pennsylvania.

Graphite and Garnet Industries in Pennsylvania. T. C. Hopkins. Tells where the minerals occur, the uses to which they are put, and their values. 1700 w. Mines & Min—March, 1901. No. 39710 C.

Power Cost.

What Is the Cost of a Horse-Power at a Colliery? Sidney F. Walker. Condensed from the *Jour. of the British Soc. of Min. Students.* Thinks the best method is to make a first approximation by calculation and then correct it by means of electric motors. 4200 w. Ir & Coal Trds Rev—March 15, 1901. No. 40026 A.

Russia.

Mining and Metallurgy in Central Russia in 1900 (Les Mines et la Métallurgie dans le Midi de la Russie en 1900). A. Spilberg. An exhaustive report prepared for the 25th Russian Mining Congress, dealing especially with coal and iron of Central Russia. 9000 w. Rev Univ des Mines—Feb., 1901. No. 39915 F.

Stamps.

Power Required by Stamps. A. W. Warwick. Calculations for determining this power, showing that the not taking into account of the inertia factor has been the cause of discrepancy between the calculated and actual power required by the stamp head. 2500 w. Min & Sci Pr—Feb. 23, 1901. No. 39542.

Stamp Mill Steam Practice. A. W. Warwick. Remarks on the power plants of 5 and 10-stamp mills, and the increase of cost due to lack of care in design or in running the steam plant of a stamp mill. 2000 w. Min & Sci Pr—March 2, 1901. No. 39681.

Timbering.

Mine Timbering (Holzmauerungen in der Grube). A. Hübner. Discussing especially the construction of partitions for the control of ventilation and the isolation of gaseous workings. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 2, 1901. No. 39935 B.

Wooden Structures in Colliery Workings. A. Hübner, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Illustrates and describes those successfully employed in the fiery pits of Northern Bohemia. 1000 w. Col Guard—March 15, 1901. No. 40030 A.

MISCELLANY.

Law.

Dutch East Indian Mining Law. A translation of the mining law of the Netherlands East Indies. 4000 w. Aust Min Stand—Feb. 14, 1901. Serial. 1st part. No. 40007 B.

Lead.

Lead Refining in Canada. Discusses the reasons for the backwardness in smelting and the absence of lead refining plants in Canada, and gives a statement of present conditions. 2000 w. Can Min Rev—Feb. 28, 1901. No. 39665 B.

Petroleum.

Notes on Petroleum in California. E. W. Claypole. The location of the fields and the advantages from the use of this product; also the geology and the future outlook. 3800 w. Am Geol—March, 1901. No. 39810 D.

Petroleum as a Fuel for Metallurgical Furnaces. A. V. Forselles, in *Technisk Tidskrift.* Information regarding its use in Russia, and the method of burning it. Ill. 1800 w. Gol Guard—Feb. 22, 1901. No. 39615 A.

Petroleum in the United States. J. Ohly. Analysis of the Denver oil basin, giving Moissan's theory and information of the output, and other matters. 3800 w. Ores & Metals—March, 1891. No. 39794.

The Coalinga Oil Field, California. W. G. Young. A brief account of a district south of the center of the state. 800 w. Eng & Min Jour—March 30, 1901. No. 40087.

Ural Mountains.

Minerals in the Ural Mountains. Information concerning the mineral deposits and the efforts being made by Russia to interest foreign capital in the mines. 800 w. U. S. Cons Repts, No. 975—March 2, 1901. No. 39586 D.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in January. Detailed list and classified summary. 5000 w. R R Gaz—March 1, 1901. No. 39560.

Dispatching.

Economic Train Dispatching. G. W. Turner. Read before the Pacific Coast Ry. Club. Discusses the subject generally, criticizing some features of present practice. 1500 w. Ry & Engng Rev—March 23, 1901. No. 40061.

Economical Handling.

Further Economies of Coal and Ore Handling. John M. Goodwin. Illustrates and describes the method patented by the writer. 1000 w. R R Gaz—March 1, 1901. No. 39559.

India.

Railways and Famine. Horace Bell. Questions whether railways, making accessible foreign markets, do not lead to too large exportation of products in time of plenty, and so in some measure cause famines. Considers conditions in India, but applicable to other countries. Discussion. 12000 w. Jour Soc of Arts—March 15, 1901. No. 40020 A.

Interurban.

Cleveland & Eastern Interurban Line. Illustrated description of this line, the sixth to be built with Cleveland as one of the termini. 1400 w. St Ry Rev—March 15, 1901. No. 39837 C.

Japan.

Japan and Its Transportation Facilities. Willard C. Tyler. An interesting address giving an account of the country, the older forms of transportation, the railroads and the steamship lines; with addresses also from Col. Joseph U. Crawford and Mr. S. Uchida, the consular representative.

14000 w. N Y R R Club—Feb. 21, 1901. No. 39795.

Transportation.

The Personnel, Material and Methods of a Railroad. L. F. Loree. An address before the Assn. of Transportation Officers, full of practical suggestions. 2000 w. R R Gaz—March 8, 1901. No. 39733.

Travelling.

Some Features of Railway Travelling, Past and Present. Frederick McDermott. Presents features showing the growth and progress, and gives facts of interest concerning early methods of conducting transportation. General discussion. 8500 w. Jour Soc of Arts—Feb. 22, 1901. No. 39593 A.

Underground.

The Metropolitan Railway of Paris (Le Metropolitain de Paris). A. Dumas. A fully illustrated account of the portion of the line already constructed, and of the power house, and a description of the experience in its operation. Two articles. 12000 w. 2 plates. Génie Civil—March 2, 9, 1901. No. 39902 each D.

Wrecks.

Some Recent Notable Train Wrecks. Reports briefly some recent wrecks, showing the strength of steel cars, and reporting strange accidents. 700 w. Eng News—March 14, 1901. No. 39789.

FINANCIAL.

Cost Comparison.

A Comparison of Costs in Iron Ore Handling and Transportation. Waldon Fawcett. Discusses the volume of ore shipments and the expenditure by lake and rail. 3000 w. Ir Age—March 21, 1901. No. 39818.

MOTIVE POWER AND EQUIPMENT.

Boston Elevated.

New Power Station and Elevated Railway System in Boston. Illustrated detailed description of the system of elevated, surface and subway tracks, and the power station, car house, etc. 4500 w. St Ry Jour—March 2, 1901. No. 39655 D.

Brake.

The Price Patent Friction Brake. Illustrated description of a tramcar brake devised to overcome the disadvantages usually found in the ordinary hand-ratchet brake. 1000 w. Elec Rev, Lond—Feb. 22, 1901. No. 39600 A.

Car Building.

Modern Car Building. An illustrated description of G. F. Milnes and Company's works at Hadley. 2600 w. Tram & Ry Wld—March 7, 1901. No. 40065 A.

Car Hoods.

Street Car Hoods or Canopies. W. E. Partridge. Illustrates and describes the Various forms in common use, discussing the designs. Also considers steam car hoods. 4300 w. St Ry Jour—March 2, 1901. No. 39657 D.

Coal Handling.

Handling Locomotive Coal on the New York Central. Brief illustrated description of the coaling and sanding station at Syracuse, and the coal storage plant at DeWitt. 700 w. R R Gaz—March 8, 1901. No. 39744.

Darwen.

Darwen Electric Tramways and Refuse Destructor. Illustrated description of a tramway installation at Darwen, England, in which steam is raised by refuse destructors. 5000 w. Tram & Ry Wld—Feb. 7, 1901. No. 39562 A.

Locomotives.

Compound Consolidation Freight Locomotives with Wide Firebox. Illustration and particulars of a new locomotive for the N. Y. C. & H. R. R. R., known as the "Central Consolidation." It is a two-cylinder compound, with a wide grate, large boiler and 210-lb. boiler pressure. 800 w. Am Engr & R R Jour—March, 1901. No. 39552 C.

Culm-Burning Switching Locomotives. Side elevation and general dimensions of engine for the D., L. & W. R. R. 350 w. Am Engr & R R Jour—March, 1901. No. 39554 C.

Express Locomotives at the Paris Exposition, 1900 (Die Schnellzug-Locomotiven auf der Weltausstellung in Paris 1900). C. Schlöss. With tabular view giving classified arrangement of exhibited locomotives. Serial. Part I. 3500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—March 15, 1901. No. 39930 B.

Express Locomotive for the Prussian State Railways (Locomotive à Grande Vitesse des Chemins de Fer de l'Etat Prussien). A. Morizot. Illustrated description of engine with the Schmidt superheater exhibited at Paris by Borsig of Berlin. 1200 w. Revue Technique—Feb. 25, 1901. No. 39906 D.

German Four-Cylinder Compound. Illustrated description of eight-wheel compound exhibited at Paris by the Hanover Construction Company. 600 w. Loc Engng—March, 1901. No. 39648 C.

Most Powerful Express Locomotive in the World. Illustration with description of an engine for the New York Central & Hudson River R. R., of the Atlantic type. The primary object was to provide a huge boiler with sufficient capacity to furnish a plentiful supply of steam at 200 pounds pressure under the most exacting conditions of service. 1000 w. Sci Am—March 16, 1901. No. 39774.

Ratios of Total Weight to Heating Sur-

face in Recent Locomotives. Gives the proportions recommended by the Master Mechanics' Assn. in 1897, with remarks on this subject. 700 w. Am Engr & R R Jour—March, 1901. No. 39553 C.

Schenectady Ten Wheel Locomotive for Cape Government Railways. Illustrated description of a ten-wheel narrow-gage engine. 700 w. Loc Engng—March, 1901. No. 39649 C.

Swiss Locomotives at the Exposition of 1900 (Les Locomotives Suisses à l'Exposition de 1900). R. Godfernaux. General description, with illustrations of the engines exhibited by the Winterthur locomotive works. 3500 w. 4 plates. Rev Gen de Chemins de Fer—Feb., 1901. No. 39911 H.

Tank Locomotive for the South-Eastern and Chatham Railway. Illustration, particulars and dimensions. 900 w. Engng—March 15, 1901. No. 40033 A.

The New Class "J" Passenger Locomotive of the Lake Shore & Michigan Southern Railway. Illustrated description of a new engine for heavy and fast passenger service. 2700 w. Am Engr & R R Jour—March, 1901. No. 39550 C.

Two-Cylinder Compound Consolidation Locomotives, Class G-1—New York Central Railroad. Illustrated description of engine designed for heavy freight service, but so equipped that they may be used in emergency on passenger trains. 55 of these engines have been ordered. 700 w. R R Gaz—March 1, 1901. No. 39557.

Ore Cars.

New 100,000-lb. Capacity Wooden Ore Cars—Chicago, Milwaukee & St. Paul Ry. Illustrated description. 500 w. R R Gaz—March 1, 1901. No. 39558.

Polyphase.

Polyphase Electric Traction. C. A. Carus-Wilson. Calls attention to some features of the polyphase system, particularly relating to punctuality and frequency of train service, that make it of great advantage; and gives an illustrated detailed description of the Burgdorf-Thun Ry. in Switzerland. 6000 w. Tram & Ry Wld—Feb. 7, 1901. No. 39563 A.

Storage Batteries.

On the Use of Storage Batteries in Connection with Electric Tramways. G. A. Grindle. Abstract of paper read before the Inst. of Elec. Engs. (Manchester). Briefly refers to the application of batteries to electric traction, and discusses the advantages by including a battery in the power system. 2200 w. Elec Rev, Lond—March 8, 1901. Serial. 1st part. No. 39803 A.

Surface Contact.

Surface Contact Systems of Electric Traction. An illustrated review of the various systems of surface contact and conduits. 3000 w. Prac Engr—March 1, 1901. Serial. 1st part. No. 39723 A.

Trucks.

Four-Wheel Passenger Truck of the Chicago, Burlington & Quincy. Illustrated description of the latest design for this road, to be used under cars weighing from 80,000 to 85,000 lbs. 500 w. R R Gaz—March 15, 1901. No. 39797.

NEW PROJECTS.

Great Salt Lake.

A Railroad Through Great Salt Lake. Kenneth C. Kerr. An illustrated account of a proposed change on the Southern Pacific, building a line across the lake from Ogden to Lucin, thus eliminating long, expensive grades, and reducing the distance and curvature. 1200 w. Ry Age (Spe. No.)—March 15, 1901. No. 39-882 D.

St. Petersburg.

The Projected Metropolitan Railway for St. Petersburg. A summary of the project taken from the *Gazette du Commerce et de l'Industrie*. It is proposed to construct a "Ring Railway," and also several lines in different quarters, with a large central station as a general junction. 1100 w. Engr, Lond—March 15, 1901. No. 40038 A.

PERMANENT WAY AND BUILDINGS.

Albany, N. Y.

The Albany Improvement on the New York Central. An illustrated account giving a general idea of the conditions overcome and the methods of prosecuting the work, which involved an expenditure of nearly two million dollars. 6000 w. Ry & Engng Rev—March 16, 1901. No. 39897.

Ballasting.

Ballasting. Report of the Com. of the Am. Ry Engng & Main. of Way Assn. with discussion. 3000 w. Ry Age (Spe. No.)—March 15, 1901. No. 39888 D.

Cardiff.

Electric Tramways in Cardiff. An outline from a local paper describing the undertaking. 900 w. U. S. Cons Repts, No. 973—Feb. 28, 1901. No. 39546 D.

Car Shops.

New Car Shops at Readville, Mass.—New York, New Haven & Hartford R. R. Engravings, illustrating the chief details of the buildings, except the power house, with description. 1500 w. Am Engr & R R Jour—March, 1901. No. 39551 C.

Conduit.

A New Slotted Conduit. A conduit designed with the object of reducing the cost necessary in the open slot conduit due to the depth of excavation required. Ill. 1500 w. Elec Rev, Lond—March 1, 1901. No. 39691 A.

Construction.

Heavy Railway Construction in Wyoming. J. I. Boggs. An illustrated description of work on the Union Pacific Railroad to reduce grades and straighten alignments. The description is confined to the heaviest part of the work on the Second Division, extending over four miles. 5000 w. Pro Am Soc of Civ Engs—Feb., 1901. No. 39580 E.

Culverts.

Rail Top Culverts. Albert Reichmann. Illustrates and describes the class of culverts built by the Chicago, Milwaukee & St. Paul Ry. Co. Discussion. 2700 w. Jour W Soc of Engs—Feb., 1901. No. 39766 D.

Electrolysis.

See Civil Engineering, Water Supply.

Freight Yards.

Freight Yards of the Chicago Transfer & Clearing Company. Plans and description of the largest railroad yard in the world, now building at Chicago. 1200 w. R R Gaz—March 8, 1901. No. 39738.

Graduation.

Graduation. The term as here used embraces the preparation of the ground, the excavation and placing of the material, and other general work incident to the formation and maintenance of the railway roadbed and yards. Report of the Committee of the Am. Ry. Engng. & Main. of Way Assn. With discussion. 9200 w. Ry Age (Spe. No.)—March 15, 1901. No. 39884 D.

Huddersfield.

Huddersfield Corporation Tramways. Reviews the history of these tramways and illustrates and describes the new equipment made necessary by the change from steam to electric traction. 6000 w. Tram & Ry Wld—March 7, 1901. No 40063 A.

Lisbon.

The Street Railway System of Lisbon. F. A. Wardlaw. An illustrated description of the street railways of this beautiful city of Portugal, the difficulties encountered, and novel features in construction and equipment introduced in changing to electricity. 5000 w. St Ry Jour—March 2, 1901. No. 39659 D.

London.

London County Council Slot Electric Tramways. Illustrated description of the conduit system proposed, noting the essential features. 3000 w. Engr, Lond—Feb. 22, 1901. No. 39610 A.

The London County Council and Electric Tramways. Discusses briefly the general aspect of the question of electrical traction in London, and gives an illustrated description of the conduit system devised by A. B. W. Kennedy. 2500 w. Engng—Feb. 22, 1901. No. 39606 A.

The Proposed Electric Conduit for the London County Council's Tramways. Illustrated description of the electric conduit which has been devised for use on the routes between Westminster Bridge and Tooting, and other routes. 1800 w. Elect'n, Lond—Feb. 22, 1901. No. 39596 A.

The Proposed Electric Conduit System of the London County Council. Illustrated description, with special reference to designs adopted in other cities. 4200 w. Tram & Ry Wld—March 7, 1901. No. 40064 A.

London's First Electric Tramway. Frederick A. Talbot. An account of the great opposition encountered, and an illustrated description of the line and its equipment. 2200 w. St Ry Jour—March 2, 1901. No. 39660 D.

Monorail.

The Proposed High-Speed Electrical "Monorail" Between Liverpool and Manchester. F. B. Behr. Describes the system and claims that it possesses the advantages of cheapness and safety as well as its adaptability for high-speed passenger traffic. 7800 w. Jour Soc of Arts—March 15, 1901. No. 40021 A.

N. Y. Central.

New York Central's Standard Engineering. Illustrated description of improvements of importance now being executed. 5500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39883 D.

The Engineering Department of the New York Central. A general outline of the immense work done by this department and the problems to be solved, and an account of recent changes of grade and line. Ill. 4800 w. R R Gaz—March 8, 1901. No. 39736.

Nottingham.

Nottingham City Tramways. Illustrated detailed description of the construction of the new overhead electric line. 3700 w. Tram & Ry Wld—Feb. 7, 1901. No. 39561 A.

Victoria Station, Nottingham, England. Description and illustrations of a fine station opened for traffic about one year ago. 1500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39885 D.

Oiled Roadbed.

The Oiled Roadbed on the Long Island Railroad. C. L. Addison. A brief statement of conditions previous to the application and the success and cost. 700 w. R R Gaz—March 8, 1901. No. 39735.

Oil House.

A Model Oil House—Chicago and Northwestern Railway. Illustrated detailed description of this part of the plant

at Clinton, Iowa. 600 w. Ry Mas Mech —March, 1901. No. 39715.

Paris.

The Prolongation of the Orleans Railway to the Quai d'Orsay (Prolongement de la Ligne d'Orleans au Quai d'Orsay). H. de la Brosse. Describing especially the difficult underpinning and supporting of buildings in running the line under the heart of Paris. 4500 w. 2 plates. Rev Gen de Chemins de Fer—Feb., 1901. No. 39910 H.

Rail Bond.

Apparatus for Determining the Conductivity of Rail Bonds (Appareil pour Déterminer la Conductance des Joints de Rails). J. A. Montpellier. A description of the Siemens & Halske device, by which the conductivity of the joint is compared with that of the solid rail. 1200 w. Electricien—Feb. 16, 1901. No. 39932 B.

Rails.

How to Study the History of a Rail. Stephen W. Baldwin. Suggests a method for measuring wear of rails and of reports to be required of inspectors. 800 w. R R Gaz—March 8, 1901. No. 39746.

Notes on Some of the Recent Discussions on Rails. Editorial on points brought out in recent papers, with a list of articles on rails which have appeared in this paper during the last 14 months. 1200 w. R R Gaz—March 8, 1901. No. 39747.

Specification for Steel Rails. P. H. Dudley. Discusses the conclusions adopted by the British Board of Trade, and the conditions and practice in the United States. 2000 w. R R Gaz—March 8, 1901. No. 39737.

The Quality of Steel for Rails. Notes from some of the reports presented at Paris, in Sept., 1900, in regard to foreign experience and practice. 1800 w. Eng News—March 7, 1901. No. 39674.

Roadbed.

Roadbed Improvements on the Union Pacific. An outline of the heavy construction work in progress, and the engineering features, with descriptions and illustrations of methods of work. 2100 w. Ry & Eng Rev—March 16, 1901. No. 39893.

San Francisco.

Some Recent Electric Railway Construction for San Francisco. S. L. Foster. Illustrated account of features introduced in changing from cable, steam and horse power to electricity. 5800 w. St Ry Jour—March 2, 1901. No. 39656 D.

Signals.

Automatic Electric Block Signal System of the Southern Hungarian Railway (Elektro-Automatische Blocksignal anlage der Ungarischen Sudbahn). O. Ehrenfest. With photographs of the apparatus and plans of the system of connections. 3000 w. Elektrotech Zeitschr—March 7, 1901. No. 39955 B.

Interlocking at the Grand Central Station, New York. Illustrates and describes the system of pneumatic interlocking and its working, giving a statement of the conditions to be met. 1800 w. Ry Age (Spe. No.)—March 15, 1901. No. 39886 D.

Low-Pressure Pneumatic Interlocking, C. & W. I. R. R., 16th Street Subway, Chicago. Illustrated description of a recently installed plant. 2300 w. Ry & Engng Rev—March 16, 1901. No. 39899.

Taylor Electric Interlocking at West Chicago, Ill. Illustrates and describes an interesting recent installation for signalling and interlocking, all the movements being controlled by electricity. 1600 w. Ry & Engng—March 16, 1901. No. 39894.

Third Rail.

Third Rail in the Baltimore Belt Line Tunnel. An illustrated description of the sectional and third-rail installations with which this line has been recently equipped. 1400 w. Sci Am—March 16, 1901. No. 39776.

Ties.

Decay of Ties and Bridge Timber. Dr. Hermann von Schrenk. Presented at the Am. Ry. Engng. & Main. of Way Assn. Gives results of recent work, the methods hitherto adopted to prevent such decay, with recommendations as to what ought to be done in the future. 2500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39881 D.

Preservation of Sleepers in England and Continental Countries. P. H. Dudley. A brief account of handling and treating sleepers by the London & North Western at Willesdon Junction, near London; and the treatment on the Belgian railroads, with illustrations of woods after years of service. 3500 w. R R Gaz—March 8, 1901. No. 39743.

Ties. The subject is divided into 8 subheads discussed by members of the Com. of the Am. Ry. Engng. & Main. of Way Assn. and discussed. 10500 w. Ry Age (Spe. No.)—March 15, 1901. No. 39892 D.

Tracks.

Track. Report of Com. of Am. Ry. Engng. & Main. of Way Assn. Individual expressions of the members of the committee, with discussion. 22800 w. Ry Age (Spe. No.)—March 15, 1901. No. 39890 D.

Uniform Track Structure. M. W. Thomson. Reviews the changes made necessary by changed conditions, and the experience with angle bars on the Pennsylvania tracks. 2200 w. R R Gaz—March 8, 1901. No. 39741.

Tunnel.

The New Street Railway Tunnel Under

Boston Harbor. J. A. Stewart. Illustrated description of interesting engineering work costing about $2,700,000. 1200 w. Sci Am—March 23, 1901 No. 39853.

Tunnels on the West Virginia Short Line Railroad. J. V. Davies. Describes this line through a very mountainous region, and illustrates and describes the extensive tunnel construction. 2800 w. R R Gaz—March 8, 1901. No. 39739.

Ventilation of the East Mahanoy Tunnel—Philadelphia & Reading. Theodore Voorhees. Illustrated description of a fan installation where advantage was taken of part of the working of the Buck Mountain coal vein, which is cut by the tunnel. 1100 w. R R Gaz—March 8, 1901. No. 39734.

Turntable.

Turntable Operation with Gasoline Engine. Illustrated description of an installation for the N. Y. C. & H. R. R. R. in New York City. 400 w. Ry & Engng Rev—March 16, 1901. No. 39898.

Water.

Water Service. Report of Com. of the Am. Ry. Engng. & Main. of Way Assn. Reports of three sub-committees considering the source of supply, method of pumping, and character of water, with discussion. 7200 w. Ry Age (Spe. No.) —March 15, 1901. No. 39891 D.

Yards.

Certain Considerations in Designing Yards. W. L. Derr. Suggestions concerning the arrangements in yards and the circumstances that should be considered in determining the yard design. 1200 w. R R Gaz—March 8, 1901. No. 39740.

The New Yard at the Grand Central Station. Plan and description of the recent rearrangement and improvements. 2300 w. R R Gaz—March 22, 1901. No. 39870.

The Re-design of Freight Yards. Shows the importance of the yard problem and discusses briefly yards well and poorly designed. 2100 w. R R Gaz—March 22, 1901. No. 39869.

The Setting Out of Yard Tracks. Particulars in regard to methods adopted in different yards, with remarks on the advantages and points needing care. Ill. 2600 w. Eng News—March 28, 1901. No. 40055.

Yard Design Regarded as a Switching Machine for Sorting Cars. F. A. Delano and G. H. Brommer. Gives a plan of a typical yard and fourteen requirements. 700 w. R R Gaz—March 8, 1901. No. 39742.

Yards and Terminals. Extracts from the report of the Maintenance of Way Assn.'s committee in reference to terms used and their definitions, and matters relating to the location, size, etc., of the yards. 3200 w. R R Gaz—March 15, 1901. No. 39798.

TRAFFIC.

Electricity and Steam.

Some Relations Between Electric and Steam Roads. Editorial discussion of relations brought about by the developments of electric traction; some of the difficulties encountered, and the conditions in New York City are discussed. 3000 w. St Ry Jour—March 2, 1901. No. 39658 D.

Freight Departments.

Two Well-Managed Express and Freight Departments. Operating details of this service as illustrated at Rochester and at Albany, N. Y. 2000 w. St Ry Rev —March 15, 1901. No. 39838 C.

MISCELLANY.

Trans-Siberian.

Historical Account of the Trans-Siberian Railway. G. de Krivochapkine. Abstract translation of article in *Le Genie Civil*. Discusses the economic influence of this railway upon the mineral industries of Siberia. Ill. 2100 w. Eng News —March 28, 1901. No. 40051.

CURRENT RECORD OF NEW BOOKS

The Book Department of THE ENGINEERING MAGAZINE *is prepared to supply any work here mentioned, at the Publisher's price, delivered post paid to any part of the world. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE. *These pages are issued separately from the Magazine, printed on one side of the paper only, for card index purposes in libraries. See introductory to "The Engineering Index."*

Marine Engineering.

Practical Advice for Marine Engineers. By Charles W. Roberts. Price, 2s. 6d., 75 cents. Size, 5 in. by 7 in.; pp. 150. London: Whitaker & Co. New York: The Macmillan Company.

A convenient little handbook describing the duties of the engineer, his relations to the other officers of the ship; the care and management of machinery at sea and in port; hints as to action in emergencies; and much useful information not usually found in the more pretentious treatises.

Flow of Water.

Report on the Measurement of the Volume of Streams and the Flow of Water in the State of New York. By Edward A. Bond, State Engineer. Size, 6 in. by 9 in.; pp. 125. Albany: James B. Lyon, State Printer.

With many tables and data of measurements, and photographs of stations, dams, and weirs, the whole forming an acceptable collection of authoritative data on the flow at various seasons from definite drainage areas.

Boilers.

Steam Boiler Economy. A Treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers. By William Kent, A. M., M. E. Price, $4.00. Size, 6 in. by 9 in; pp. 458. New York: John Wiley & Sons. London: Chapman & Hall.

The extensive experience and high reputation of Mr. Kent gives reason for hearty welcome to this work, which has been awaited with interest. It treats of the chemistry of fuel and combustion, the heating values of American and European coals, furnaces, methods of firing, mechanical stokers, and forced draft. The general construction of steam boilers is discussed and the best method of operating them so as to obtain the highest efficiency. The whole forms a complete treatise on steam boiler economy, and as such it is to be welcomed.

Gas Fuel.

Gas and Fuel Analysis for Engineers. By Augustus H. Gill, S. B., Ph. Price, $1.25. Size, 5 in. by 8 in. New York: John Wiley & Sons. London: Chapman & Hall.

A compendium prepared especially for the use of students at the Massachusetts Institute of Technology, but also of usefulness for those interested in the economical application of fuel. Methods of analysis of chimney gases are given, together with details of the computations and preparation of the necessary reagents. The anaylsis of fuels and the determination of the calorific value are also treated.

Boiler Practice.

Steam Boiler Practice in Relation to Fuels and Their Combustion. By Walter B. Snow, S. B. Price, $3.00. Size, 6 in. by 9 in.; pp. 297. New York: John Wiley & Sons. London: Chapman & Hall.

A study of the principles involved in the production of steam from water, considered apart from the questions involved in boiler construction and design. The treatment includes the efficiency of fuels, efficiency of boilers, and especially the comparative advantages of natural and mechanical draft. The rules of the American Society of Mechanical Engineers for conducting boiler trials are given in an appendix.

Reservoirs.

Reservoirs for Irrigation, Water-Power, and Domestic Water-Supply. By James Dix Schuyler. Price, $5.00. Size, 6 in. by 9 in.; pp. 432. New York: John Wiley & Sons. London: Chapman & Hall.

An excellent treatise, based upon the authors paper prepared for the United States Geological Survey, extensively revised and enlarged. The construction of artificial reservoirs by means of rock-fill dams, hydraulic-fill dams and dams of masonry and of earth are all discussed, and illustrated by examples of actual construction. Much important matter relating

to the projected reservoirs based on the work of the United States Geological Survey in the arid regions of the western states is given, and tables of reservoir areas and capacities are appended.

Calculus.

An Elementary Treatise on the Calculus for Engineering Students. By John Graham, B. A., B. E. Price, 7s. 6d. London: E. & F. N. Spon.

A thoroughly practical treatise, intended, as the title indicates, for the engineer. The fundamental principles of the differential and integral calculus are clearly developed, and numerous practical applications are appended.

Fuels.

The Calorific Power of Fuels. By Herman Poole, F. C. S. Price, $3.00. Size, 6 in. by 9 in.; pp. 279. New York: John Wiley & Sons. London: Chapman & Hall.

A new edition of Mr. Poole's well-known treatise, with many corrections and extensions, including additions to the list of fuels, new smoke tests, additional tables, etc.

Roads.

Report of the Commissioner of Public Roads of the State of New Jersey. By Henry R. Budd, State Commissioner. Size, 6 in. by 9 in.; pp. 190. Camden: S. Chew & Sons.

Containing much useful information as to the construction and maintenance of macadam roads, with numerous illustrations of the results of construction work in various parts of the state, together with photographs of roads in other parts of the world. A good map, and numerous tables are included.

Sewage.

Report of the Massachusetts State Board of Health Upon the Discharge of Sewage into Boston Harbor. X. H. Goodnough, Chief Engineer. Size, 6 in. by 9 in.; pp. 100. Boston: Wright & Potter Printing Co.

A complete review of the present sewage disposal of the city of Boston, and an examination of the proposed plan of delivery into the harbor in such a manner and at such a place as will be unobjectionable. An excellent map is appended.

Mechanism.

The Marvels of Modern Mechanism. By Jerome Bruce Crabtre. Size, 6 in. by 9 in.; pp. 750. Springfield, Mass.: The King-Richardson Co.

A popular resume of the development of the various branches of modern industry, showing the relations of material prosperity upon the applications of machinery. With numerous illustrations of ancient and modern works.

Artillery.

L'Artillerie a l'Exposition de 1900. Par Le Colonel X. Price, francs 7.50. Paris: Vve. Ch. Dunod.

A general review of the artillery exhibits at the exposition, with numerous illustrations, and a comparison of the practice of different countries.

Electrical Directory.

The "Electrician Electrical Trades Directory and Handbook for 1901." Price, 12s., 6d. London: George Tucker.

Including the usual valuable handbook of electrical information, also records of electrical undertakings in all parts of the world, and an exhaustive classified directory of the professions and trades connected with electricity in Great Britain, the Colonies, the United States, Asia, Africa, and Central and South America.

Mining.

A Text Book of Coal Mining, for the Use of Colliery Managers and Others. By Herbert W. Hughes. Price, 24s. London: Charles Griffin & Co.

The fourth edition of this well-known handbook, very completely revised and enlarged. The work has been in part rewritten, and is very fully illustrated.

Canal.

Report of the State Engineer and Surveyor on the Proposed Barge Canal from the Hudson River to the Great Lakes. By Edward A. Bond, State Engineer. Albany, N. Y.: James B. Lyon, State Printer.

Giving the surveys and estimates for the three routes from the Hudson River to Lake Erie, with diagram to facilitate a comparison of routes, and much information upon which to base discussion and opinion.

Hydraulics.

Water Power. By Joseph P. Frizell. Pp. 563, 26 tables. New York: John Wiley & Sons. London: Chapman & Hall.

Treating mainly of the collection of water for power purposes, including rainfall, run-off, and the flow of rivers; followed by a discussion of the construction of dams and reservoirs. Methods of calculation, and their application are given to the comparison of various forms of construction for dams.

Dredging.

Concurso Para la Presentacion de Proyectos de Trenes de Dragado. Republica Argentina; Ministerio de Obras Publicas. 7 in. by 10 in.; pp. 240, 42 plates. Buenos Aires: Guillermo Kraft.

The official report of the competition of dredging machinery for the improvement of the harbour of Beunos Aires and the port of Rosario, with complete specifications and plates of the various machines.

IMPROVED MACHINERY

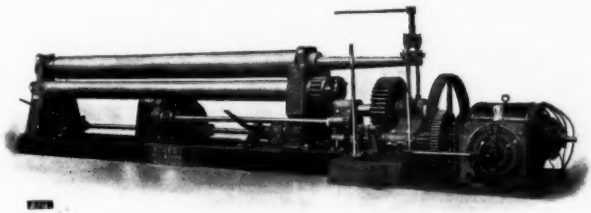
New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Electrically Driven Bending Rolls.

THE electrically driven bending rolls shown herewith are solid wrought iron forgings arranged in pyramid form, and have a capacity for bending plates up to 12 inches in width and 5/8 of an inch thick.

The lower rolls are geared together while the upper or bending roll is revolved by the friction of the plate in passing through. It is adjustable by power to suit the thickness of the plate and the radius to which it is to be bent. It has a hinged bearing at one end which may be turned down out of the way, while the other end has a long shank extending to a third support which retains the roll in position for the removal of rings or flues. This will be found a great advantage in boiler and other shops where plates are to be bent to a complete circle.



Midway between the housings a set of supporting rollers are placed to give additional stiffness to the lower rails.

For very long machines additional sets of rollers are added.

The machine is firmly tied together by a heavy cast-iron soleplate. It is very strongly geared and all parts are made stiff and substantial.

Suitable levers and clutches are conveniently placed for the quick and easy control of all the operations.

The machine is driven by an 18 H. P. reversible, constant-speed Bullock motor. For controlling the motor, an automatic rheostat is used to prevent the operator from throwing on the full current too quickly and burning out the motor.

The field consists of a circular yoke of special steel. While particular attention has been given to a reduction in weight, it has not been at the sacrifice of efficiency.

The pole pieces, built up from soft sheet steel of the highest magnetic quality, are securely bolted to the yoke. The shape of the punchings are such as to produce a saturated pole face, and this feature, coupled with carefully proportioned windings, is largely responsible for the sparkless operation of the motor, and is a feature greatly appreciated by engineers.

The field coils are machine wound and carefully insulated. The shunt and series coils of compound wound machines are separately wound. The coils are slipped over the pole before it is bolted to the yoke, and, should it be necessary, are readily removed.

The armature core is built up from thin, carefully annealed sheet steel, possessing a high magnetic permeability. These discs are again annealed and then japanned. They are mounted upon the shaft and held firmly together by malleable iron end plates.

The windings, which are let into slots provided in the periphery of the armature core, are made of either copper bars or wire as best suits the requirements. The coils are machine formed, and after being formed are thoroughly insulated with mica and other high grade insulations. They are then baked in steam heated forms while under pressure, which removes all moisture and produces a perfect and very compact coil. The result is a coil that is less liable to be injured than when produced by the ordinary method and one which requires no further insulation when placed in position on the core. The coils of armatures are held in position by wedges of hard, thoroughly dried wood, driven into notches provided near the top of the slots.

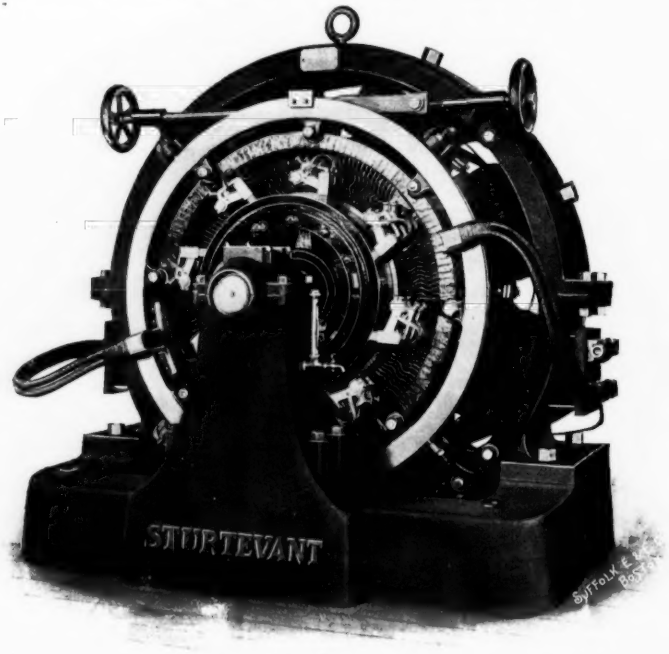
The commutators are built from drop forged bars of pure lake copper with selected mica insulation. They possess great durability and have an exceptionally even wearing surface for the brushes.

The brush holder is simple and highly efficient, giving absolutely no trouble. It is of the reaction type; no adjustment of the brushes is necessary, and when they are once set the motor will operate in either direction without sparking and under all variations of load.

The Sturtevant Eight-Pole Motors.

THE motors of this type as manufactured by the B. F. Sturtevant Co. of Boston, Mass., were primarily designed for the direct connected driving of large fans at low speeds. They are therefore capable of great range of speed, are exceptionally compact and of high efficiency. These qualities especially fit them for direct connection to machine tools and the like.

The magnet frames are of cast steel, cast iron or wrought iron, according to size or requirements. In the smallest sizes the field cores are cast with the frame and the pole shoes only are removable, but, in the larger sizes readily detachable cores of wrought iron are bolted to the frame.



Barrel wound armatures of the toothed-hollow-drum type are usually employed. The laminations are of special steel plate mounted in each case upon a cast iron spider, the hub of which is extended to support the commutator. All machines except those for very low speed and high voltage are bar wound, the two-circuit type being usually adopted. This makes possible the

use of a single pair of brushes where only small brush capacity is required. These machines are built in sizes from 1-100 to 50-100, the ratings being based on the H. P. delivered per 100 revolutions.

The eight-pole generators, of which one is illustrated herewith, are the same in design as the motors of the same type and in the larger sizes the shunt and series coils of the field windings are wound and insulated entirely separate. The brush holder rigging for supporting the holders is so arranged that brushes of opposite polarity are carried on independent rings which are attached to but insulated from a common ring which is readily detachable. On a small machine adjustment is by hand, on a large machine by means of a hand wheel and screw. The self-contained character of the armature and commutator especially fits these machines, both motors and generators, to any piece of apparatus, the generators being particularly adapted for engine-driven sets. The same thorough system of protecting against oil and water is employed as in the construction of the other types of machines, of Sturtevant manufacture. The large radiating surface and thorough ventilation makes it possible to run these machines at full speed with a maximum temperature rise not exceeding 30° Cent. on the hottest part.

All sizes are provided with self-aligning, ring-oiling bearings, the sizes below the 15-100 motor being supported in tripod hangers while the larger sizes are equipped with pedestals and complete bases.

The generators are, like the motors, built in ten sizes ranging in capacity from 3 K. W. to 100 K. W.

Shop and Factory Telephones.

NEXT in importance to labor saving appliances, if not of prime importance, is the saving of the time of each employee in the place, from the highest to the lowest. To

this end careful attention is given to reducing the system of labor to its natural sequence in order to avoid the loss of time and labor. To supplement this saving of time and bring all departments within quick communication with each other, a telephone system is most useful and will soon be considered a necessity. Shop and factory telephones can now be obtained at reasonable

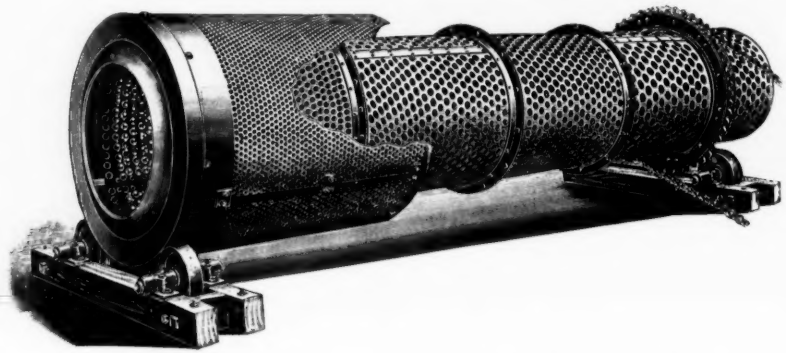
prices and of superior quality, arranged to fully meet the requirements and which will cause little trouble and expense to keep in working order.

The Ericsson Telephone Co., of New York, is supplying, especially for factory and shop uses, intercommunicating systems, the instruments being made with lever, plug or automatic switches using the hand or small watch-case receiver and transmitter, as shown herewith, or combined receiver and transmitter. For large systems, where a number of telephones are required, they arrange for placing all batteries together and to call automatically by taking the receiver from the hook. Also, if desired, they supply magneto instruments for calling in the usual manner by turning a crank, either for intercommunicating use or with central switchboard.

The systems supplied by this company are now in use in shops and factories, hotels, offices and exchanges, and they furnish the instruments and adapt the system to any requirements and for any use desired. By referring to their numerous installations and exhibiting a variety of orders, they show that the Signal Corps, War Department, U. S. Government have approved of their make and have placed some large orders for Ericsson telephones; that shops, factories, offices, hotels, mines, railways and telephone exchanges, are equipped with their instruments; that orders are sent them by customers in all parts of the U. S. A., from Canada, Mexico, South America, South Africa, Hawaii, the Philippines and from far away Siberia. Full and definite information as to systems, etc., may be had from the Ericsson Telephone Co.

Beckley Revolving Screen.

THE Beckley Perforated Screen Works, Garwood, N. J., have installed for Messrs. Wright and Lindsley, Great Notch, N. J., an interesting revolving screen built in the style of the Montana grizzley. The illustration herewith gives a very clear idea of the simple mounting and effective driving mechanism. The screen is 52" in diameter, twenty feet long, and sorts about 400 tons of broken stone daily in five sizes and tailings. Fuller particulars and information as to special applications may be had from the manufacturers mentioned above.

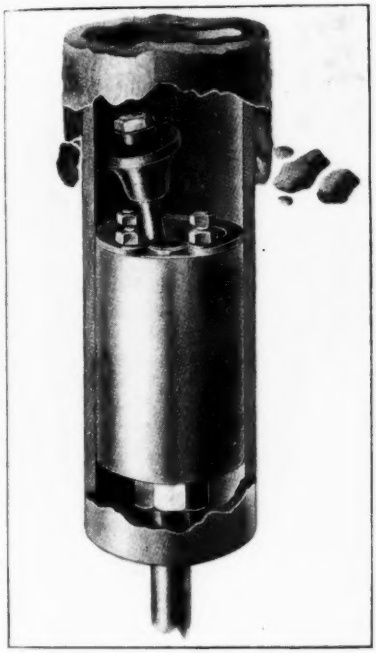


A New Boiler Tube Cleaner.

THE device illustrated herewith is designed to remove scale from the outside of tubes in a return tubular boiler. Practically nothing heretofore could be had, and the common method has been to attempt to hammer off the scale by reaching in and around the tubes. But the tubes are crowded so closely together, and so near the shell, that only a few could be reached, and those only on one side. The picture shows how the device operates. The cleaner is practically a little engine, operating by steam or compressed air. At the end of what would be the piston rod on a large engine is a small iron vibrator or oscillator, made with the same curve as the tube.

Having been connected by a steam hose with an adjacent boiler the cleaner is introduced at the front of one of the tubes to be

cleaned. When the steam is turned on the vibrator commences its oscillating movement, increasing its strokes rapidly as the pressure is raised to forty or fifty pounds, which is the normal steam pressure required. By this time the machine is making from 800 to 1,000 strokes a minute. The result is that the accumulations of scale are



loosened and detached by a countless number of light blows, without injuring the tube.

But if a tube be very thin or has been seriously weakened by a long period of incrustation, the cleaner will detect the flaw, when it would be impossible to discover it by the most careful inspection.

A variation of this cleaner adapts it to the removal of scale in water-tube boilers.

Manufactured by the Wm. B. Pierce Co., 327 Washington St., Buffalo, N. Y.

Blower System of Ventilation and Heating.

THE particular features of this combined system of ventilation and heating in which a fan is employed to distribute the heated air are thus summarized in a recent lecture by Walter B. Snow, of the engineering staff of the B. F. Sturtevant Co., Boston, Mass. "The entire heating surface is centrally located, enclosed in a fire-proof casing, and placed under the control of a single individual, thereby avoiding the possibility of damage by leakage or freezing incident to a scattered system of steam piping and radiators. The heater itself is adapted for the use of either live or exhaust steam, and provision is made for utilizing the exhaust of the fan engine, thereby reducing the cost of operation to practically nothing. At all times ample and positive ventilation may be provided with air tempered to the desired degree. Absolute control may be had over the quality and quantity of air supplied. It may be filtered and cleansed, heated or cooled, dried or moistened at will. By means of the hot and cold system, the temperature of the air admitted to any given apartment may be instantly and radically changed without the employment of supplementary heating surface.

"The pressure created within the building is sufficient to cause all leakage to be outward, preventing cold inward drafts and avoiding the possibility of drawing air from any polluting source within the building itself. By returning the air, using live steam in the heater and operating the fan at maximum speed, a building may be heated up with great rapidity, as is usually desirable in the morning.

"The area of heating surface is only one-third to one-fifth that required with direct radiation, while the primary cost and operating expense of a fan is far less than that of any other device for moving the same amount of air."

Industrial Notes.

The fire which visited the works of the B. F. Sturtevant Co. at Jamaica Plain, Mass., on April 14th, proves to be far less disastrous than was first reported. Only the engine and electrical departments were injured. The power plant was started up with but a single day's delay incident to renewing belts damaged by fire, and the entire blower, heater, forge, galvanized iron and shipping departments, with the foundry, pattern shop, etc., were in full operation on that day and the shipments going forward as usual.

F. L. Smidth & Co., New York, engineers and builders of cement manufacturing machinery, have received the contract for equipping with Davidsen Patent Tubemills the plant of the Iroquois Portland Cement Company, now building at Caledonia, New York.

The new machine shops being erected at Elizabethport, N. J., for the Central Railroad of New Jersey, will be equipped exclusively with the Lundell power apparatus manufactured by the Sprague Electric Company. The equipment will consist of three 100 K. W. generators of 240 volts and 250 R. P. M., direct-connected to Ball & Wood engines, and 75 motors of various sizes for driving the machine tools.

The Ashton Valve Co. have recently appointed Mr. Frank J. Corbett as assistant manager of their New York office, at 121 Liberty street. He will more especially introduce their lines of Ashton pop safety valves and steam gages among the architects and stationary engineers of New York. Mr. Geo. E. Hubbert, 123 North Fourth street, Philadelphia, Pa., has been appointed general agent of the same company.

The American Bridge Company will furnish the Crown Agents for the Colonies of Great Britain the steel work for two deck plate girder spans, and for strengthening two other bridges on the Jamaica Government Railway.

The Consolidated Railway Electric Lighting and Equipment Company, New York, has established a branch office in The Rookery, Chicago, with its general agent, Col. John T. Dickinson, in charge.

Owing to a steadily increasing demand for their tools the Philadelphia Pneumatic Tool Co. have found it necessary to largely increase their shop, so that they now have a frontage on Ridge avenue, Eleventh and Noble streets, and for greater convenience and larger offices removed on April 10th to 1038 Ridge avenue, corner of Noble street.

The Eastern Graphite Roofing Co., manufacturers of stone-faced roofing, moved their offices in April from Jersey City, N. J., to the Gerken Building, 90 Chambers street, New York City.

Owing to the increase of business at Chicago the Bethlehem Steel Company will on May 1st move its offices in that city to larger quarters in rooms Nos. 1520 and 1521 Marquette Building, where Mr. E. Nelson, sales agent, will continue to represent them.

The Bullock Electric Manufacturing Company, of Cincinnati, and the Wagner Electric Manufacturing Company, of St. Louis, have effected a combination of their selling organizations. The product of Bullock Company consists of a complete line of direct and alternating current machines, from a ½ horse power motor to a 10,000 K. W. generator; controllers of various types and rotary transfomers. The product of the Wagner Electric Manufacturing Company covers a full line of static transformers of all types and of the largest sizes; ammeters, voltmeters, indicating wattmeters, switches, switchboards for all purposes and single phase self-starting alternating current motors. The entire absence of complicated starting mechanism especially adapts the Wagner single phase motor to pumping plants and machinery of like character. The two lines will be under the management of Mr. E. H. Abadie, formerly sales manager of the Wagner Company.

The Stephenson Mfg. Co., of Albany, N. Y., manufacturers of bar belt dressing, are now represented in Philadelphia by Mr. George E. Hubbert, 123 N. Fourth street, and in Chicago by Seehausen, Wehrs & Co., 11 S. Canal street.

The John A. Roebling's Sons Company took the first important step last month in the making and laying of the cables for the New East River Bridge at New York. The contract was awarded to the company several months ago and the preparation of plans and other preliminary work, as well as the main part of the contract, which is to follow, is under the supervision of Mr. Charles G. Roebling, the president of the company, who is assisted by Mr. William Hildenbrand. The work done was the placing in position of the 2¼-inch diameter ropes which support the temporary foot bridge on which the workmen will stand during the main work of cable laying. Several methods of getting the first line across have been employed in the past, and kites, swimmers and other agents have been tried, but the method employed on this occasion has, we believe, never been tried before, and

a distinct advance over all previous ones. The method adopted was to carry the drum containing the cable across the river on a float (one end having been previously secured) and pay out the cable, allowing it to rest on the river bed until at the proper time it could be raised from the water and to the desired height by means of a stationary engine and drum. The first cable was successfully raised on April 11th, the time required being only seven minutes, navigation being, of course, suspended during that period.

The Wefugo Company, Cincinnati, Ohio, mention the following among water softening plants for which they have recently taken orders for purifying feed water. The quantities are gallons per twenty-four hours: Marion Steam Shovel Co., Marion, O., 28,800 gals.; National Tube Co., Versailles, Pa., 43,200 gals.; Traders Papers Co. (Sulphite Mill), Lockport, N. Y., 96,000 gals.; Tytus-Gardner Paper & Mfg. Co., Middletown, O., 96,000 gals.; Carnegie Steel Co., Howard Axle Works, Homestead, Pa., 240,000 gals.; Santa Barbara Ice Co., Santa Barbara, Cal., 9,600 gals.; Distilled Ice & Cold Storage Co., Los Angeles, Cal., 14,400 gals.; Water Works, Paris, Ill., 14,400 gals.; Colin Gardner Paper Co., Middletown, Ohio, 33,600 gals.; Clinton Iron & Steel Co., Pittsburg, Pa., 192,000 gals.; Cambria Steel Co., Franklin Furnaces, Conemaugh, Pa., 1,440,000 gals.; American Steel Hoop Co., Isabella Furnaces, Etna, Pa., 480,000 gals.; Pressed Steel Car Co., McKees Rocks, Pa., 288,000 gals.

The New York Continental Jewell Filtration Co. have been awarded the contract for installing a 32,000,000 gallon (daily capacity) mechanical filtration plant at Little Falls, N. J., for the East Jersey Water Co.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

HARRISON BROS. & CO., Inc., Philadelphia, Pa.—"Specifications for the Painter," prepared for the use of architects, house painters, etc., and offers a practical handbook for the paint specification writer in the selection of the paint best adapted to the special case in hand.

AMERICAN CEMENT CO., Philadelphia.—"History of the Portland Cement Industry in the United States. A handsomely illustrated 150-page book giving not only a general history of cement and the cement industry, but much valuable data, and many excellent illustrations of buildings, dams, viaducts, etc.

FREDERICK T. SNYDER & CO., Chicago, Ill.—An attractive brochure about hoisting, air compressing, pumping and power transmission plants, as well as stamp mills, concentrators, sampling, cyanide and chlorination plants.

MONTAUK MULTIPHASE CABLE CO., New York.—Descriptive circular of a fire-detecting cable for use wherever an early warning of fire is important. This cable consists of a central plain wire with a thin coating of soft metal; then comes the usual insulating coats, different, however, in being impregnated with a flux; wound spirally around this are about a dozen fine wires, completing the circuit.

STERLINGWORTH RAILWAY SUPPLY CO., Easton, Pa.—Extensive and illustrated catalogue of rolled steel brake beams, trucks, and malleable castings.

DIAMOND DRILL & MACHINE CO., Birdsboro, Pa.—Leaflet illustrating the Jackson belt lacing machine, showing that quick operation and low cost of both machine and work are among its important features.

PHILADELPHIA BOURSE, Philadelphia, Pa.—Handbook giving a description of the Bourse, its origin and aims.

RIVETT-DOCK CO., Brighton, Boston, Mass.—Very handsomely printed catalogue illustrating in detail a novel thread-tool, which cuts in the same manner as would the teeth of a die if applied to the work separately and successively, reserving the fine point for the last cut. The care necessary in using the single pointed tool is eliminated, and any person capable of reversing

a lathe can at once cut accurate and finished screws.

BURROWS MFG. CO., Williamsport, Pa.—An interesting catalogue of the Burrows air pump regulator and low-water alarm feed-water regulators, and the Keelam damper regulator.

INGERSOLL-SERGEANT DRILL CO., New York.—Very extensive and handsome catalogue of air compressors for mine and shop service.

WATERBURY ROPE CO., New York.—A very complete and interesting catalogue of ingots, billets and wire rods, wire, iron and steel wire rope, manila and sisal rope and binder twine.

C. W. HUNT CO., West New Brighton, N. Y.—A well printed catalogue describing the Hunt conveyor and other machinery for handling coal, ashes, and similar materials in power stations.

B. F. STURTEVANT CO., Boston, Mass.—An illustrated catalogue of disc and propeller fans for the forcing of air through extended piping systems, and for the production of mechanical draft or for the conveying of light materials.

CHARLES A. STICKNEY CO., St. Paul, Minn.—A handsome catalogue showing a line of power engines, combined engines and pumps, deep-well engines, combined engines and air compressor, direct-connected outfits, combined engines and hoists, and portable engines.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J.—"Graphite as a Lubricant," being a booklet giving much information and testimony as to the efficiency and economy of graphite for lubrication.

J. T. SLOCUMB & CO., Providence, R. I.—A leaflet showing a suggestion for graduated dials on the cut-adjusting screws of machine tools. The advantage is that the plan affords a ready and accurate way of measuring work, and an accurate means of adjusting cutting tools in accordance with these measurements.

INDUSTRIAL WATER CO., New York.—An attractive pamphlet, containing reprints, with illustrations, of articles on "The Cause of Foaming in Locomotive Boilers," and other papers, by Mr. C. Herschel Koyl, originally published in the *Railroad Gazette*. The treatment is clear-cut and the series as reprinted forms a valuable acquisition to locomotive literature.

KENDRICK & DAVIS, Lebanon, N. H.—Small catalogue of battery motors and fans, electrical measuring instruments, and igniting dynamos for gas engines.

ERICSSON TELEPHONE CO., New York.—Catalogue of telephones and equipment especially adapted to factory and shop use.

VEZIN MACHINE CO., New York.—A leaflet showing a four-cylinder engine of high speed for direct connection to dynamos, fans, centrifugal pumps, and high speed machinery.

INTERNATIONAL ARITHMACHINE CO., New York.—Descriptive circular of a calculating machine, weighing only one pound, for addition, subtraction, multiplication and division.

STANLEY ELECTRIC MFG. CO., Pittsfield, Mass.—Bulletins Nos. 114, 115 and 116 of the S. K. C. frequency changer, high-voltage testing sets, and high-voltage ground detectors.

CHARLES ENGELHARD, New York.—Excellent catalogue of Le Chatelier's pyrometer for measuring temperatures between 0-1600° Celsius (2920° Fahrenheit). The instrument is constructed according to the directions of the Royal Physical Technical Institute, Charlottenburg, near Berlin, by the W. C. Heraeus Platinum Works at Hanau, Germany.

KENT MILL CO., New York.—A descriptive catalogue, with explanatory illustrations of the Kent mill for pulverizing or granulating stones, quartz, ores, cement, sand, phosphate rock, or any hard substance.

JENKINS BROS., New York.—A business-like catalogue of a full line of valves, and packing for steam, gases, water, oils and acids.

ELECTRIC STORAGE BATTERY CO., Philadelphia, Pa.—Bulletin No. 64, showing typical installations of "chloride accumulators" in mills and factories.

BALL & WOOD CO., New York.—A large and very handsome catalogue of automatic cut-off engines, horizontal and vertical, for high speeds in both belted and direct connected types.